B O N N E V I L L E   P O W E R   A D M I N I S T R A T I O N

Red River Wildlife Management Area HEP Report

Habitat Evaluation Procedures

Technical Report 2004 | November 2004 | DOE/BP-00004478-4

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Bonneville Power Administration
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RED RIVER WILDLIFE MANAGEMENT AREA HEP REPORT

Submitted By

Paul R Ashley – RHT Coordinator

Columbia Basin Fish and Wildlife Authority

To

Idaho Department of Fish and Game

Regional HEP Team Members

(2004)

Paul R Ashley – RHT Coordinator

Brandy Ellis – Team Member

Jeff Krueger – Team Member

Dan Varnell – Team Member

Sheri Whitfield – Team Member

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Abstract

A habitat evaluation procedures (HEP) analysis conducted on the 314-acre Red River Wildlife Management Area (RRWMA) managed by the Idaho Department of Fish and Game resulted in 401.38 habitat units (HUs). Habitat variables from six habitat suitability index (HSI) models, comprised of mink *(Mustela vison),* mallard *(Anas platyrhynchos),* common snipe *(Capella gallinago),* black-capped chickadee *(Parus altricapillus),* yellow warbler *(Dendroica petechia),* and white-tailed deer *(Odocoileus virginianus),* were measured by Regional HEP Team (RHT) members in August 2004. Cover types included wet meadow, riverine, riparian shrub, conifer forest, conifer forest wetland, and urban. HSI model outputs indicate that the shrub component is lacking in riparian shrub and conifer forest cover types and that snag density should be increased in conifer stands. The quality of wet meadow habitat, comprised primarily of introduced grass species and sedges, could be improved through development of ephemeral open water ponds and increasing the amount of persistent wetland herbaceous vegetation e.g. cattails *(Typha spp.)* and bulrushes *(Scirpus spp.).*

Study Area

The 314-acre RRWMA study area is located approximately 15 miles southeast of Elk City, Idaho (Figure 1). The study area is bounded by the Nez Perce national Forest on the east and west and private property to the north and south.

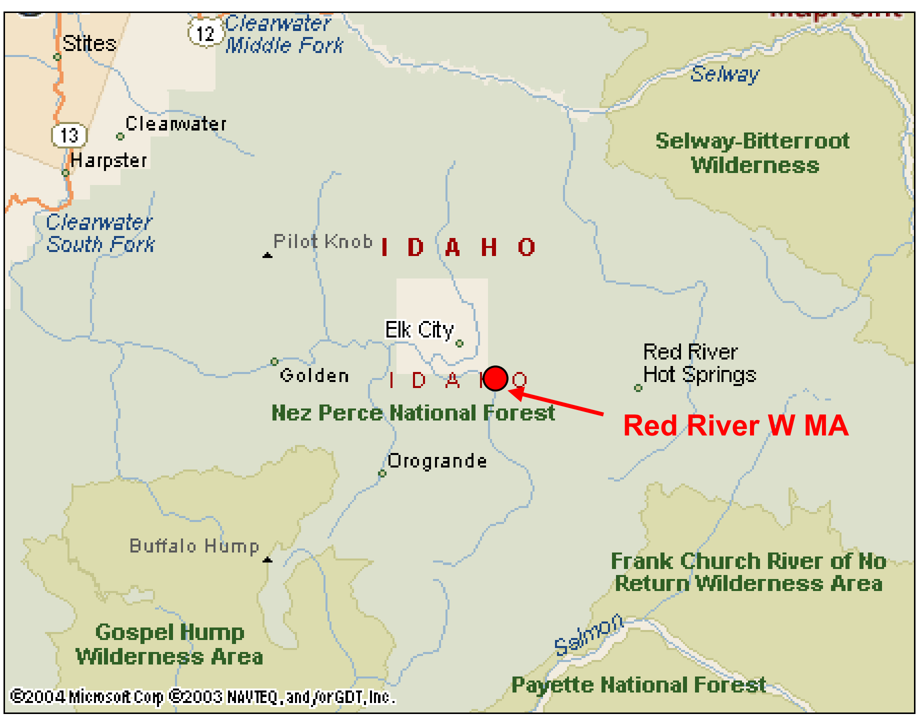

Figure 1. Location of Red River Wildlife Management Area.

Study Site Description

The study area is principally a wet meadow complex (≈266 acres) co-dominated by reed canary grass *(Phalaris arundinacea),* Timothy grass *(Phleum pretense),* and sedges *(Carex spp.)*. Other grass species observed by RHT members, in descending order, include Kentucky bluegrass *(Poa pratensis),* redtop bentgrass *(Agrostis alba),* timber oatgrass *(Danthonia intermedia),* brome grass *(Bromus spp.)*, and introduced wheatgrass *(Agropyron spp.)*. Noted forbs include yarrow *(Achillea millifolium),* aster *(Aster spp.)*, cinquefoil *(cinquefoil spp.),* camas *(Cammasia quamish),* and bur-reed *(Sparganium spp.)* (herbaceous species described in this document are not all inclusive, but provide the reader with a basic description of the plant community (floristics) observed by RHT members while conducting HEP transects).

Several small stands of conifer forest (≈22 acres) dominated by lodgepole pine *(Pinus contorta latifolia)* punctuate the RRWMA. A homogenous quaking aspen *(Populus tremuloides)* stand present within a conifer site on the west side of the project area was included as part of the conifer forest cover type for HEP evaluation purposes.

Other conifer tree species reported include grand fir *(Abies grandis),* and Engelman spruce *(Picea engelmannii)*. Grand fir and Engelman spruce detected on HEP transects were understory trees ≤ 16 feet tall (mature trees were observed near transect routes, but were not a significant element of the overstory canopy). Similarly, lodgepole pine regeneration (trees ≤ 16 feet tall) was also documented.

Herbaceous cover within conifer forest stands included the same species identified on wet meadows sites. Herbaceous species composition varied predicated on whether the forest site was mesic or xeric.

Riparian shrub cover (≈ 24 acres) is restricted to what project managers have planted. Shrub cover is extremely limited along the Red River and appears stressed by ungulate depredation and competition from herbaceous cover. Shrubs detected on HEP transects include willow *(Salix spp.),* dogwood *(Cornus sericea),* and alder *(Alnus spp.).*

The incidence of noxious weeds on the RRWMA appears to be minimal and is generally associated with disturbed sites. Spotted knapweed *(Centaurea maculsa)* was detected on Transect 8 while Canada thistle *(Cirsium arvense)* was observed on Transect 4 and lateral Transect 5C. Similarly, knapweed, common mullein *(Verbascum thapsus),* St. John's-wort *(Hypericum perforatum)* were present along lateral Transect 13B.

Methods

Background

A habitat evaluation procedures analysis was conducted at the Red River Wildlife Management Area to determine baseline habitat conditions. HEP, developed by the U.S. Fish and Wildlife Service (USFWS), is used to quantify the impacts of development, protection, and restoration projects/measures on terrestrial and aquatic habitats by assessing changes, both negative and positive, in habitat quality and quantity (USFWS 1980), (USFWS 1980a).

HEP is a habitat based approach to impact assessment that documents change through use of a habitat suitability index (HSI). The HSI value is derived from an evaluation of the ability of key habitat components to provide the life requisites of selected wildlife and fish species.

The HSI value is an index to habitat carrying capacity for a specific species or guild of species based on a performance measure (e.g. number of deer per square mile) described in HEP species models. The index ranges from 0.0 to 1.0. A HSI of 0.3 indicates that habitat quality/carrying capacity is marginal while a HSI of 0.7 suggests that habitat quality/carrying capacity is relatively good for a particular species (Table 1).

Table 1. A comparison of mathematical HSI scores and equivalent verbal expressions.

Habitat Suitability Index	Verbal Equivalent
0.0 < 0.2	Poor
0.2 < 0.4	Marginal
0.4 < 0.6	Fair
0.6 < 0.9	Good
0.9 < 1.0	Optimum

Each increment of change is identical. For example, a change in HSI from 0.1 to 0.2 represents the same magnitude of change as a change from 0.2 to 0.3, and so forth. Habitat variables, suggested mensuration techniques, and mathematical aggregations of assessment results are included in HEP evaluation species models.

HEP Model Selection

The Red River Wildlife Management Area HEP evaluation was completed by the Regional HEP Team (RHT) and Idaho Fish and Game staff in August 2004. Initial HEP model selection was based on habitat types and loss assessments associated with the Black Canyon and Deadwood projects (Meuleman 1986). Whenever possible, HEP models cited in Meuleman (1986) were used in the evaluation. Additional and/or substitute HEP models were used as required.

The Red River project cover type/species matrix was developed from information gleaned from the Black Canyon/Deadwood project Wildlife Impact Assessment (Meuleman 1986). Black Canyon/Deadwood project assessment HEP evaluation species are correlated with cover types in Table 2.

Table 2. Black Canyon/Deadwood project HEP species matrix.

HEP Species	COVER TYPE								
	DFW	EFW	DSSW	EW	EF	SS	AG	R	L
Mule Deer	X	X	X		X	X			
Mallard			X	X				X	X
Canada Goose			X	X				X	X
Pheasant						X	X		
Mink			X	X				X	X
B. C. Chicadee	X	X							
Yellow Warbler			X						
Spruce Grouse		X			X				
Yellow-rumped Warbler		X			X				
HEP Species Stacking - Black Canyon Project	2	2	5	3	1	2	1	3	3
HEP Species Stacking - Deadwood	1	3	3	1	2	1	0	1	1
(black)	HEP species applied to both Black Canyon and Deadwood projects								
(magenta)	HEP species applied only to Black Canyon project								
(red)	HEP species applied only to Deadwood project								

Bonneville Power Administration (BPA) recommended that the Red River HEP analysis be based solely on the Black Canyon project (Joe DeHerrera, BPA, pers comm. 2004). As a result, Deadwood project HEP species were not included in the final Red River project HEP species matrix except where they overlap Black Canyon HEP models (Table 2).

RHT staff compared the biological appropriateness and efficacy of utilizing Black Canyon Assessment HEP models to similar guild/assemblage HEP models that may better represent Red River project habitat attributes of interest. Suggested HEP species changes were discussed with Idaho Fish and Game staff (Miles Benker, IDFG, pers comm. 2004); resulting in two HEP model substitutions i.e., white-tailed deer replaced mule deer[1] and snipe replaced Canada goose[1]. HEP species substitution rationale is as follows:

> White-tailed deer frequent the Red River project site. The white-tailed model emphasizes the palatable woody shrub component within riparian and forested cover types which is currently lacking. Snipe HEP model habitat attributes stress soil moisture and compaction factors (feeding opportunities) and herbaceous cover. This model is superior to the Canada goose model at documenting wet meadow function. The goose model emphasizes island availability (nesting sites) and feeding areas (geese regularly feed on golf courses, heavily grazed pastures, and lawns). Goose model variables do not necessarily reflect existing wet meadow physiographic conditions and/or habitat attributes of interest.

The final Red River project species matrix includes habitat unit "stacking" considerations (Table 3). HU stacking for each cover type is based primarily on the need to document key ecological correlates (KECs) and structural conditions for each cover type and, secondarily, the number of species per cover type used in the Black Canyon Assessment (Meuleman 1986). Red River HEP model habitat variables and measurement techniques are described in Table 4. HEP models are included in Attachment 1.

[1] Mule deer and Canada goose HSI models were used in the Black Canyon Assessment.

Table 3. Red River Wildlife Area cover type/species selection matrix.

HEP Species*	Conifer Forest Wetland	Riparian Shrub**	Wet Meadow	Conifer Forest	Riverine
White-tailed Deer[1]	X	X		X	
Snipe[2]			X		
Mallard		X	X		
Mink	X		X		X
B. C. Chicadee	X[3]			X[3]	
Yellow Warbler		X			

* HEP model sustitutions/modifications were made after consultation with IDF&G staff (M. Benker)

** Same as deciduous shrub-scrub wetland habitat type

1. White-tailed deer was substituted for mule deer.
2. Snipe was substituted for Canada goose.
3. B.C. Chickadee was added to the conifer forest cover types to capture tree and snag structural conditions.

Table 4. HEP model variables and suggested measurement techniques.

Model	Variable	Variable Definition	Measurement Technique
Mink	V1	Percent tree, shrub, and/or persistent emergent herbaceous vegetation	Line/point intercept and/or grid
(Allen 1984)	V2	Percent of year with surface water present	Local input
	V3	Percent of wetland basin dominated by persistent emergent herbaceous vegetation.	Grid
	V4	Percent canopy cover of trees/shrubs within 100m of the wetland edge.	Line/point intercept
	V5	Shoreline development factor	Remote sensing (aerial photos) and/or local input
Mallard	V1	Percent available water that is slow moving, shallow, and open	Local input, direct observation, map/aerial photo mensuration.

Model	Variable	Variable Definition	Measurement Technique
(Anon.1986)	V3	Summer Cover-% shoreline dominated by emergent or scrub - shrub vegetation	Line/point intercept
	V4	Distance between water suitable for brood rearing and dense herbaceous cover ≥ 8 inches tall	Remote sensing (aerial photos), field measurements, and/or local input
	V5	Number and quality of wetland types and habitat features within a one mile radius	Remote sensing (aerial photos), field observation, and/or local input
Snipe	V1	Moisture content SI	Local input/direct observation
(Anon. 1978)	V2	Average height of herbaceous vegetation	Robel pole/height measurement rod
	V3	Soil compaction SI	Soil test penetrometer or field estimation
Black-capped Chickadee	V1	Percent Tree Canopy Closure	Point intercept (densitometer)
(Schroeder 1983)	V2	Average height of overstory trees	Clinometer, forestry stick
	V4	Number of snags 4 to 10 inches DBH	Belt Transect, DBH tape
Yellow Warbler	V1	Percent deciduous shrub cover	Line/point intercept
(Schroeder 1982)	V2	Average height of deciduous shrubs	Measurement tape, surveyors rod
	V3	Percent deciduous shrub cover comprised of hydrophytic shrubs	Analysis of V1 results
White-tailed Deer	V1	Percent cover of palatable shrubs	Line/point intercept
(Anon. no date)			

Cover Type Mapping

Cover types were delineated based on information found in the Red River Wildlife Management Area Long Range Management Plan (White 1999), limited aerial photographs, and on-site reconnaissance. General cover types include wet meadow, riparian shrub, riverine, conifer forest, conifer forest wetland, and urban (urban includes the wildlife area headquarters building and associated structures and was not assigned a habitat evaluation species). Cover type acreage and descriptions are listed in Table 5.

Table 5. Red River project cover type acreage and descriptions.

Cover Type	Acres	Description
Wet Meadow	266.39	Moist to wet soil pastures dominated by sedges, Timothy grass, reed canary grass, and Kentucky bluegrass (may include standing water for a portion of the year).
Riparian Shrub	24.31	A 50 foot buffer on both sides of the Red River that currently supports and/or potentially could support hydrophytic/phreatic woody vegetation.
Riverine	0.00 (24.31)	The Red River channel between the "green-lines". The mink model includes a 100 meter buffer on each side of the river as well as the river channel. The RHT included riverine under riparian shrub acreage.
Conifer Forest Wetland	2.60	Overstory dominated by evergreen trees with a herbaceous understory comprised primarily of wetland obligate and/or facultative vegetation.
Conifer Forest	19.70	Overstory dominated by evergreen trees with a shrub/herbaceous understory comprised primarily of upland obligate and/or facultative plant species.
Urban	1.00	Project buildings, kiosk, and parking areas.
Total	**314.00**	

General cover types were mapped with Maptech Terrain Navigator 2002 Pro software ® and are illustrated on Figure 2. The riverine cover type includes the riparian shrub buffer due to map scale limitations.

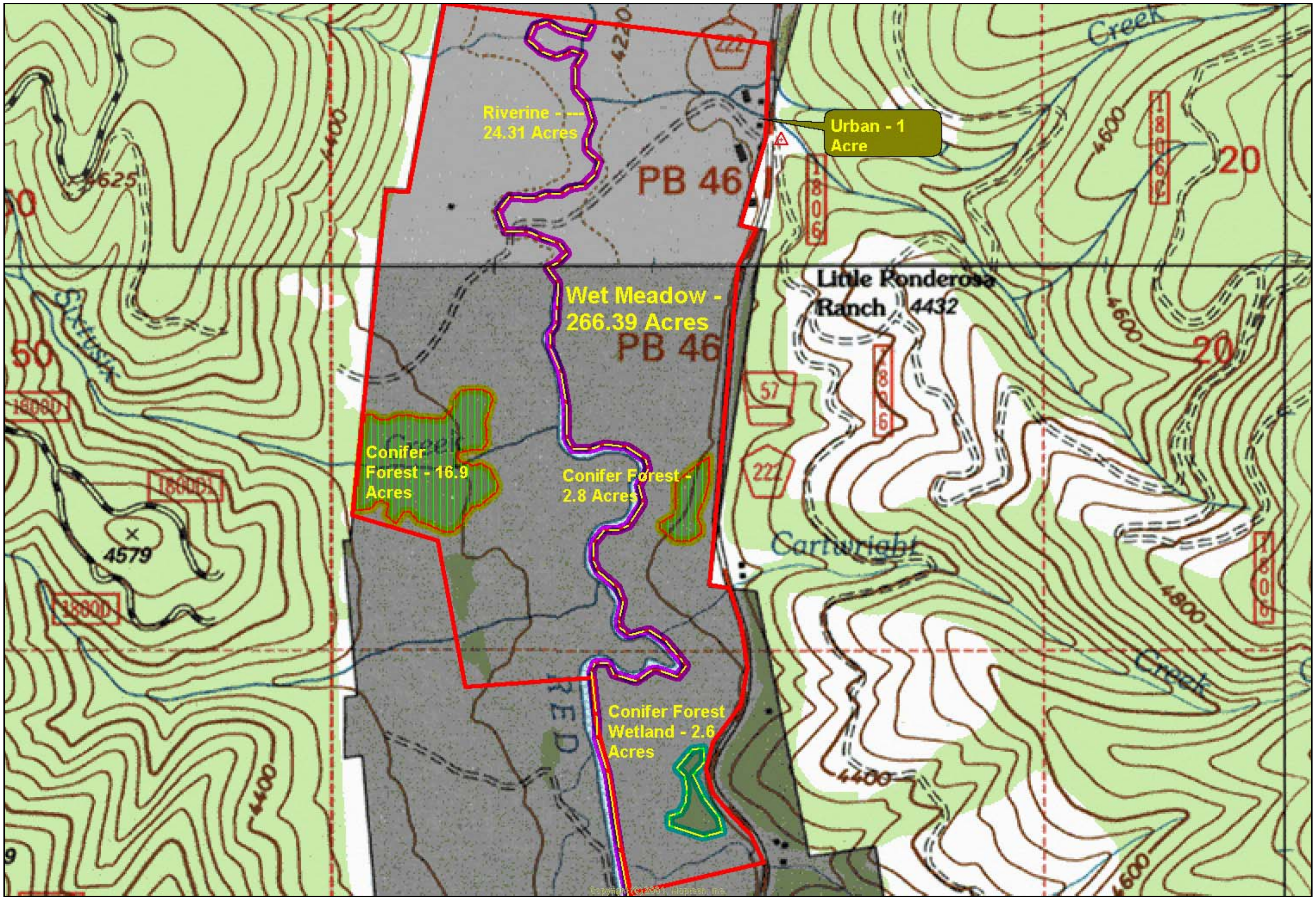

Figure 2. Red river project general cover types.

HEP Transect Site Selection

The specific methodology for selection of evaluation sites for all cover types follows a probabilistic (statistical) sampling procedure, allowing for statistical inferences to be made within the area of interest. The following protocols describe how transect sites were selected.

- HEP evaluation sites were selected by combining stratified random sampling elements with systematic sampling. Project sites are stratified by cover types (strata) to provide homogeneity within strata, which tends to reduce the standard error, allows for use of different sampling techniques between strata, improves precision, and allows for optimal allocation of sampling effort resulting in possible cost savings (Block et al. 2001). Macro cover types such as conifer forest were further sub-cover typed based on dominant vegetation and/or physiographic features e.g., emergent herbaceous understory, percent tree cover, deciduous versus evergreen shrubs, conifer versus deciduous forest. Cover type designations and maps were validated prior to conducting surveys in order to reduce sampling inaccuracies.

- Specific transect locations within strata were determined by placing a Universal Transverse Mercator (UTM) grid over the study area (strata) and randomly selecting "X" and "Y" coordinates to designate transect start points (or through use of a computer random coordinate program). Random transect azimuths were selected from a standard random number table. Data points and micro plots are systematically placed along the line/point intercept transect at assigned intervals.

- Transect start points on microhabitat sites (e.g., conifer forest wetland) were selected subjectively as required to ensure that the cover type was sampled.

Transects were established at least 300 feet from the perimeter of a cover type, when possible, to reduce bias from "edge effect" and anthropogenic influences (roadways etc.). Wet meadow transects were 300 feet in length while riparian shrub and conifer forest transects ranged from 300 to 900 feet in length. Riparian shrub transects were established along the "green line" (Winward 2000). Most lateral wet meadow transects were established at equidistant points along and generally perpendicular to riparian shrub transects. Transect UTM coordinates and lengths are listed in Table 6 and shown on Figure 3.

Table 6. Red River HEP transects, UTM coordinates, magnetic azimuths, and length.

TRANSECT	POINT	UTM COORDINATES		MAG AZ	LENGTH (ft)	TOTAL LENGTH (ft)
2	Start	0625117	5066018	330	300	
	Turn	0625094	5066115	360	300	
	End	0625122	5066200			**600**
3	Start	0625024	5066282	014	300	
	End	0625070	5066361			**300**
4	Start	0625117	5066540	353	300	
	End	0625127	5066630			**300**
5	Start	0624942	5066588	274[1]	900	
	End	0625008	5066733			**900**
5A	Start	0624942	5066588	206	300	
(lateral)	End	0624879	5066531			**300**
5B	Start	0624863	5066664	260	300	
(lateral)	End	0624863	5066663			**300**
5C	Start	0625008	5066733	260	300	
(lateral)	End	0624913	5066745			**300**
7	Start	0624553	5066743	247	300	
	Turn	0624466	5066738	330	300	
	Turn	0624442	5066830	285	300	
	End	0624371	5066875			**900**
8	Start	0625086	5066700	005	550	
	End	0625136	5066864			**550**
10	Start	0624968	5067046	067	300	
	End	0625061	5067039			**300**
13	Start	0624796	5067548	132[1]	900	
	End	0624640	5067414			**900**
13A	Start	0624796	5067548	050	300	
(lateral)	End	0624877	5067588			**300**

TRANSECT	POINT	UTM COORDINATES		MAG AZ	LENGTH (ft)	TOTAL LENGTH (ft)
13B	Start	0624697	5067475	154	300	
(lateral)	End	0624706	5067392			**300**
14	Start	0625028	5067716	230[1]	300	
	End	0624951	5067693			**300**
14A	Start	0625028	5067716	140	300	
(lateral)	End	0625080	5067631			**300**
14B	Start	0624996	5067700	320	300	
(lateral)	End	0624966	5067788			**300**
14C	Start	0624951	5067693	140	300	
(lateral)	End	0624984	5067605			**300**
Total						**7,450**

[1] Initial azimuth; transect follows river "green line".

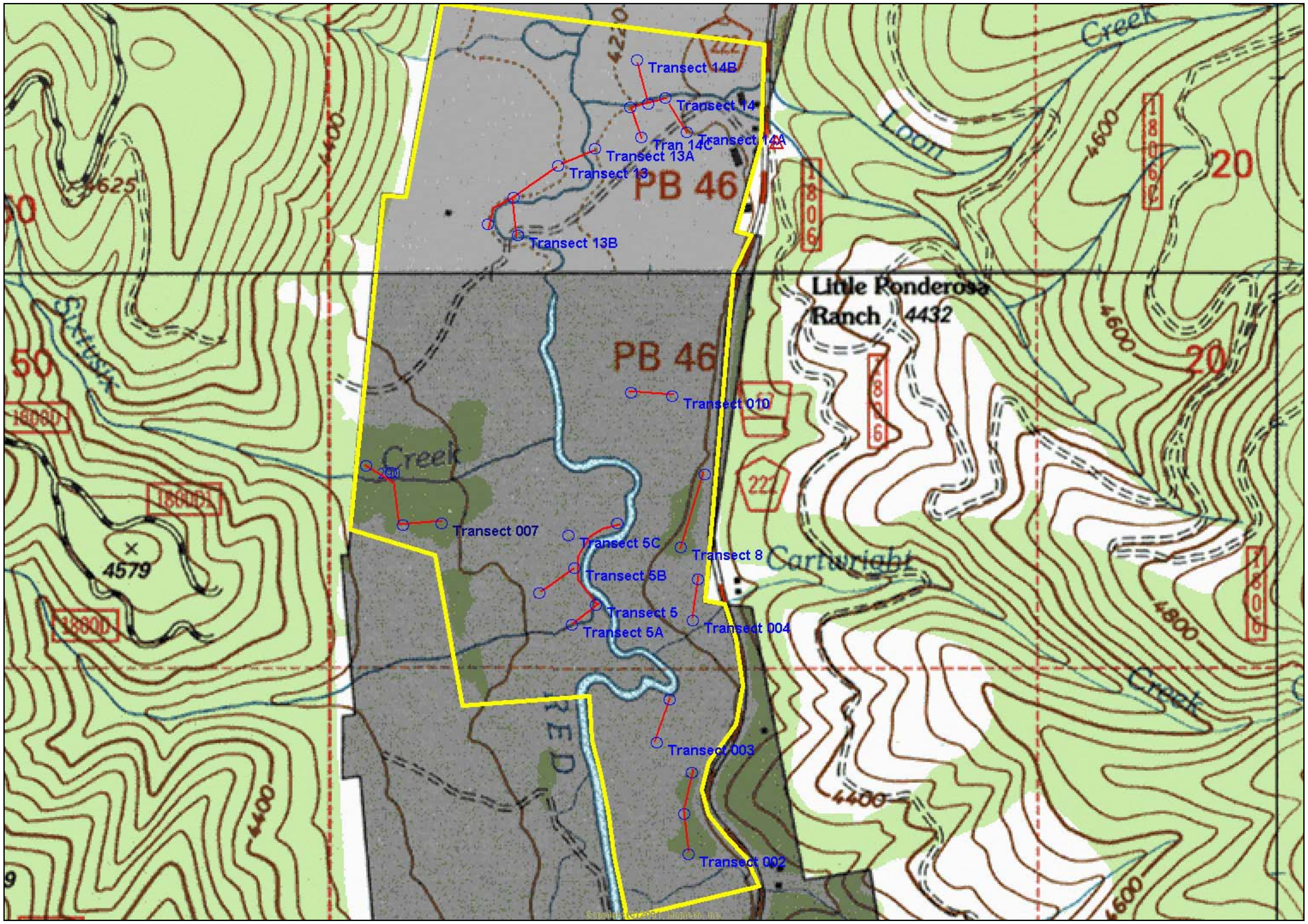

Figure 3. Red River Wildlife Management Area HEP transect locations.

Sampling Design and Measurement Protocols

Pilot studies were conducted to estimate the sample size needed for a 95% confidence level with a 10% tolerable error level (Avery 1994) and to determine the most appropriate sampling unit for the habitat variable of interest i.e., a coefficient of variation analysis (BLM 1998). In addition, a power analysis was conducted on pilot study data (and periodically throughout data collection) to ensure that sample sizes are sufficient to identify a minimal detectable change of 20% in the variable of interest with a Type I error rate ≤ 0.10 and P = 0.9 (BLM 1998, Block et al. 2001).

1. Herbaceous measurements were taken at 20 or 25 foot intervals (review specific transect summaries/data sheets for details) on the right side of the tape (the right is determined by standing at 0 feet and facing the line of travel/transect azimuth). RHT members walked on the left side of the transect line to reduce sample disturbance. A rectangular $0.1m^2$ micro-plot quadrat (square in shape) was used to estimate percent cover of herbaceous vegetation (a coefficient of variation analysis of various quadrat shapes and sizes during the pilot study showed little variation; therefore, the smaller $0.1m^2$ micro-plot quadrat was selected). The near right hand corner of the quadrat was placed at the sampling interval (rectangle quadrats are placed with the long axis perpendicular to the tape, and the lower right corner on the sampling interval). Quadrat samples are considered independent samples for statistical purposes.

2. Herbaceous height was measured with a measuring rod placed within the quadrat frame (scale = 10ths/inches). Three evenly spaced measurements were recorded and averaged for each sample. Only leaf material was measured (leaves provide the greatest amount of cover). Grass inflorescence was not included in height measurements.

3. A Robel pole (Robel 1975) was used to document herbaceous vegetation visual obstruction readings (VOR). Measurements were taken at 20 or 25 foot intervals (review specific transect summaries/data sheets for details). Four observations were recorded and averaged per point to obtain a single visual obstruction reading or VOR (two measurements are taken four meters from the point on the transect line on opposite sides of the cover pole from a height of one meter; two measurements are taken from the point perpendicular to the transect line of travel). Sample size was determined to be adequate when the "running mean" varied ≤ 10% of the mean (VOR results are graphed in data summaries located in Appendix A. Robel pole samples are considered independent samples for statistical purposes.

4. Scrub shrub vegetation was limited. As a result, the line intercept method (USFWS 1981) was used to document shrub cover at the Red River project site. The following criteria is the basis for determining whether to employ point intercept or line intercept techniques to measure shrub cover.

Shrub canopy cover is measured using a point intercept method if shrub cover is estimated greater than 5%. If shrub cover is estimated at >20%, shrub point data is collected every 5 feet (20 possible "hits" per 100 ft segment). If shrub canopy cover is between 5% and 20%, point data is collected every 2 feet (50 possible "hits" per 100 feet segment). If shrub cover <5%, results that are more accurate are obtained using the line intercept method. Regardless of method, the sampling unit is a 100-foot segment of the transect for statistical purposes.

Shrub height measurements were collected on the tallest part of a shrub that crossed directly above/below each sampling intercept mark (discrete measurements). Although not observed on Red River transects, it is possible to have overlapping shrub canopies.

5. Tree canopy cover measurements were recorded at five or ten foot intervals with a densitometer. Measurement interval was determined by visually estimating tree canopy closure prior to initiating the survey. If estimated canopy closure was less than 10%, measurements were taken at five-foot intervals; if estimated greater than 10% canopy closure, a ten-foot interval was used. As with shrubs, the sampling unit is a 100 foot segment of the transect.

6. Snag data was documented with belt transects. RHT members collected snag data in conjunction with tree canopy closure measurements using the same baseline transect. Snags were detected and recorded within a tenth-acre belt transect paralleling the baseline transect (44 feet wide by 100 feet long i.e., 22 feet on each side of the baseline transect). As with shrubs and trees, the sampling unit was each 100-foot segment. Although not used at Red River, snag data could be collected within a 37.2-foot radius circular plot (1/10 acre) located at the end of each 100-foot segment.

7. Tree basal area information was collected at 100-foot intervals using a "factor 10" prism. Each 100-foot interval basal area observation (all tree "hits" at each 100-foot point) was considered an independent sample.

8. Photo points were established at the start point of each transect. Current habitat conditions were documented with a Canon G1® 3.3 pixal digital camera (no magnification). Pictures were recorded from a height of three feet at the beginning of each transect facing the transect azimuth. A reference cover board was placed at the 30 foot mark on each transect (Appendix A).

The process for determining transect length (sample size) varied based on the variable measured. The "running mean" was used to estimate variance for VOR while shrub and tree cover sample size was estimated as follows:

Percent cover within each 100 foot sample unit was divided by sample unit length to obtain percent shrub/tree cover per sample unit (e.g. 10 feet of cover/100 feet = 10 percent shrub cover). The standard deviation was then calculated for percent cover data from sample units. Sample size (transect length) was determined through use of the following equation:

$$n = \frac{t^2 s^2}{E^2}$$

Where: t = t value at the 95 percent (0.05) confidence interval for the appropriate degrees of freedom (*df*); s = standard deviation; and E = desired level of precision, or bounds (± 10 percent). The same method was used to determine sample size for plot frames based on total percent cover for herbaceous species.

Although the desired confidence level is as stated in the previous paragraph, actual confidence intervals (CIs) in herbaceous cover were generally > 0.05 (95 percent) due to the homogenous nature of wet meadow habitats. In contrast, actual CIs for shrub and tree cover typically ranged from 0.2 to 0.05 (80 to 95 percent).

Analysis

Habitat vegetation and structure data was tallied on Excel ® spreadsheets developed for CBFWA by Richard Stiehl (summaries are included in Appendix A; actual spreadsheets are included on the accompanying CD). Data results were applied to individual HSI model habitat variables to obtain suitability indices (SI) for individual habitat variables and habitat suitability indices for each transect.

Habitat variable SI values were recorded on HSI model spreadsheets by cover type (see accompanying CD). Suitability index results were "pooled" from multiple transects to obtain an "average" SI for each habitat variable and cover type. HEP model habitat suitability indices were calculated based on the "pooled" data and mathematical aggregations for each HEP model (Table 7).

Table 7. Habitat suitability indices for Red River Wildlife Management Area HEP species.

Cover Type	HEP Model	Habitat Suitability Index
Wet Meadow		
	Mink	0.05
	Mallard	0.54
	Snipe	0.77
Total		
Conifer Forest Wetland		
	Mink	0.05
	B. C. Chickadee	0.45
	White-tailed Deer	0.00
Total		
Riverine		
	Mink	0.46
Total		
Riparian Shrub		
	Mallard	0.59
	Yellow Warbler	0.03
	White-tailed Deer	0.00
Total		

Cover Type	HEP Model	Habitat Suitability Index
Conifer Forest		
	B. C. Chickadee	0.50
	White-tailed Deer	0.00
Total		
Urban	N/A	
PROJECT TOTAL		

Results

In addition to HEP model variable information, RHT members collected habitat structure data including Robel pole measurements (Robel 1975), forest basal area, and percent herbaceous cover to provide project managers with additional site-specific ecological information (Appendix A).

HEP Model Results

HEP transects were established on wet meadow (n=14), riparian shrub/riverine (n=3), conifer forest (n=2), and conifer forest wetland (n=1) cover types. Results include 401.38 habitat units from six HSI models i.e., mink, mallard, common snipe, black-capped chickadee, yellow warbler, and white-tailed deer. Habitat suitability indices and habitat units are summarized by cover type in Table 8 (the urban cover type was not evaluated) and for each species in Table 9.

Table 8. Habitat suitability indices/habitat unit summary.

Cover Type	Acres	HEP Model	Habitat Suitability Index	Habitat Units
Wet Meadow				
		Mink	0.05	13.32
		Mallard	0.54	145.12
		Snipe	0.77	205.43
Total	266.39			363.87
Conifer Forest Wetland				
		Mink	0.05	0.13

Cover Type	Acres	HEP Model	Habitat Suitability Index	Habitat Units
		B. C. Chickadee	0.45	1.16
		White-tailed Deer	0.00	0.00
Total	**2.60**			**1.29**
Riverine				
		Mink	0.46	11.28
Total	**24.31**			**11.28**
Riparian Shrub				
		Mallard	0.59	14.45
		Yellow Warbler	0.03	0.64
		White-tailed Deer	0.00	0.00
Total	**(Same as Riverine)**			**15.09**
Conifer Forest				
		B. C. Chickadee	0.50	9.85
		White-tailed Deer	0.00	0.00
Total	**19.7**			**9.85**
Urban	**1.0**	N/A		**0.00**
PROJECT TOTAL	**314**			**401.38**

Table 9. HEP species model habitat unit summary.

HEP Species	Conifer Forest Wetland HUs	Riparian Shrub HUs	Wet Meadow HUs	Conifer Forest HUs	Riverine HUs	Total HUs
White-tailed Deer	0	0		0		0
Snipe			205.43			205.43
Mallard		14.45	145.12			159.57
Mink	0.13		13.32		11.28	24.73
B. C. Chickadee	1.16			9.85		11.01
Yellow Warbler		0.64				0.64
Total HUs	1.29	15.09	363.87	9.85	11.28	401.38

Discussion

The results of the HEP analysis clearly indicate that the general lack of shrub cover is a limiting factor along the Red River and within conifer forest cover types. Habitat suitability for mink, white-tailed deer, yellow warbler, and a myriad of other wildlife species would benefit significantly by increasing the shrub component (especially hydrophytic shrubs in riparian areas). Establishing shrubs and trees along the Red River would also aid in the stabilization of stream banks and enhance fish resources by providing shade, habitat for additional food (insects), and eventually improved stream structure through the introduction of woody debris. Aggressive active restoration and associated maintenance, including temporary ungulate fencing, are needed to improve the shrub component within riparian shrub/riverine and conifer forest cover types.

As identified in variable five of the mallard model, the development of open water palustrine habitats comprised of both ephemeral ponds (≤ 4 months post winter), and semi-permanent ponds (>4 months ≤ 6 months post winter) within the wet meadow cover type would diversify local area wetland structure and provide an opportunity for establishment of persistent emergent herbaceous vegetation. Moreover, the suitability index of mallard model variable one, “percent of water that is slow moving, shallow, and open,” would also increase. Palustrine enhancements would improve habitat suitability for waterfowl, amphibians, and other wildlife species.

Pooled conifer forest/conifer forest wetland HEP data results indicate that, overall, black-capped chickadee habitat is “fair” (HSI=0.50; range: 0.00 to 0.71). Transect 7 data points out that percent tree canopy cover is the limiting habitat variable on that site; however, continued natural forest succession (passive restoration) should result in increase forest canopy cover. In contrast, black-capped chickadee habitat suitability on the site represented by Transect 8 is clearly limited by the lack of suitable snags as well as tree canopy cover. Natural forest succession should result in improved habitat quality in the long term.

Critique

Future wet meadow cover type mallard and snipe HEP transects should be initiated in the spring during the nesting/brood rearing season to document habitat conditions at those critical times. Data from future spring HEP surveys can be compared to data obtained by the RHT and/or new transects conducted in mid August to determine if results are significantly different. Although important, temporal considerations are often beyond the control of the wildlife managers and/or the RHT. Every effort, however, should be made to conduct HEP surveys during appropriate seasons.

Mallard model variables one and three are ambiguous at best. Variable one, “percent available water that is slow moving, shallow, and open enough to allow dabbling ducks to feed,” does not quantify the minimum amount of water necessary to support ducks relative to the amount of surrounding habitat i.e., the variable suggests that if ≥75 percent of the available water meets the criteria, the SI is 1.0. Does this mean that if ≥75 percent of the available water in an area the size of a bathtub meets the criteria, that the variable SI would be 1.0 for a 400 acre wet meadow complex? Because variable one pertains to feeding, water depth limits, emergent vegetation types, and benthic composition within open water areas should be identified as well. The SI for variable one is, therefore, highly subjective. *RHT members used best professional judgment and anecdotal information provided by IDF&G to support assigned SI values for this variable.*

Likewise, variable three, “summer cover-percent shoreline dominated by emergent or scrub - shrub vegetation” is also unclear. Variable output suggests that if ≥50 percent of the shoreline is dominated by emergent or scrub – shrub vegetation, the variable SI is ≥ 0.70. How does that relate to percent horizontal cover and cover height? The term “shoreline” also needs defined. On one hand, “emergent vegetation” suggests the presence of water, while scrub – shrub vegetation may not. Did model author(s) define “shoreline” as a “belt” encompassing both aquatic and terrestrial habitats? This variable is difficult to quantify and cannot be measured objectively without further definition and therefore is also subjective. *RHT members did, however, take into account herbaceous cover measurements and considered similar variables from other mallard models before assigning a SI value to variable three.*

In contrast, snipe model variable two, “average height of herbaceous vegetation” does require collecting height data, but the model does not quantify percent herbaceous cover. Future iterations of the snipe model should include a variable, perhaps multiple variables that describe horizontal cover and desired plant composition.

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APPENDIX A

Transect 2 Data Synopsis

Figure 4. Transect 2 photo point - August 2004.

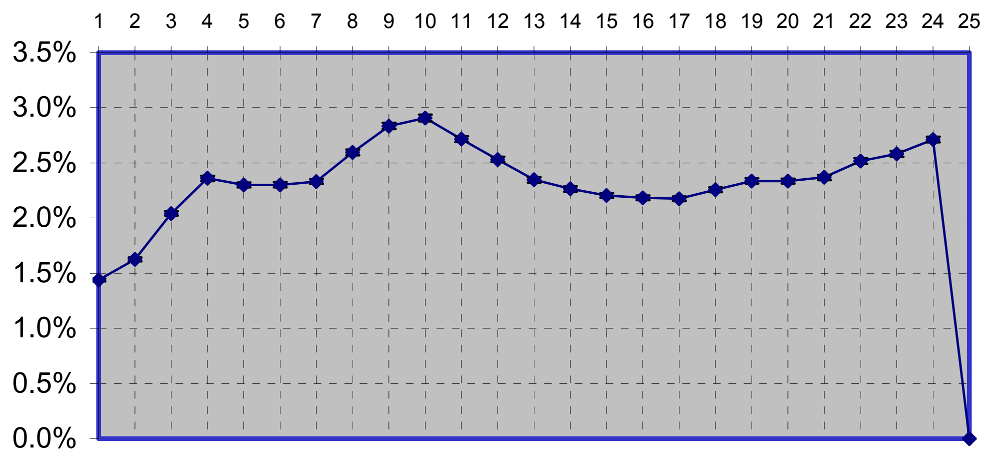
VOR POINT RESULTS

	GPS COORDINATES		Mag AZ	Length
Start	625117	5066018	330	300
Turning Pt.	625094	5066115	360	300
Turning Pt.				
Turning Pt.				
End	625122	5066200		600

Area: Red River WA
Date of study: 08/17/04
Transect Number: 2
Investigators: pa

Covertype: EFW
Unit of measure: foot
Interval: 25
Number of points: 24
Sample unit size: ind.
Height unit of measure: decimeter

VOR running mean



24 **OF** **24** **SAMPLE POINTS**

SHRUB TRANSECT RESULTS

Area: Red River WA
Date of study: 08/17/04
Transect Number: 2
Investigators: pa

Covertype: Evergreen Forested Wetlan
Transect Type point intercept
Unit of measure: feet
Interval: 2'
Sample unit size: 100
Height unit of measure: 10ths/ft

	GPS COORDINATES		Mag AZ	Length
Start	625117	5066018	330	300
Turning Pt.	625094	5066115	360	300
Turning Pt.				
Turning Pt.				
End	625122	5066200		600

Shrub Intercept Data: 300 POINTS NEEDED 300 POINTS ENTERED 299 POINTS are BARE

Species	N	% CC	Mean height	s	%cc s	y	%cc y	m	%cc m	d	%cc d	vd	%cc vd	dd	%cc dd
Snowberry	1	0.3%	11.0	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%

AGE DISTRIBUTION	N	%
Seedling	0	
Young	0	
Mature	0	
Decadent	0	
Very Decadent	0	
Dead	0	

Overall Height	
MEAN	11.00
MODE	#N/A
MAX	11.0
MIN	11.0
ST.DEV	N/A
TOTAL CC	0.3%

AGE KEY

Symbol	Meaning
s	seedling
y	young
m	mature
d	decadent
vd	very decadent
dd	dead

MICROPLOT RESULTS

Area: Red River WA
Date of study: 08/17/04
Transect Number: 2
Investigators: pa

Covertype: EFW
Transect Type line intercept
Unit of measure: feet
Interval: indepenedent
Number of plots 24

	GPS COORDINATES		Mag AZ	Length
Start	625117	5066018	330	300
Turning Point	625094	5066115	360	300
Turning Point				
Turning Point				
End	625122	5066200		600

Microplot Data: 24 **PLOTS NEEDED** 24 **PLOTS ENTERED** 1 **PLOTS BARE**

Microplot frame size: 0.10m square **Mean Veg height** 7.3 **10ths/ft**

Plot interval: 25 **% CC TOTAL** 91.3%

			GRASS % CC	FORB % CC	EXOTIC % CC
%CC	emerg. herb cvr.	91.3%			
%CC	Basal area (Ft/ac)	100.0%			
%CC	- - - - - -				
%CC	- - - - - -				
			TOTAL %cc Grass 0.0%	TOTAL %cc Forbs 0.0%	TOTAL %cc Exotic 0.0%

TREE TRANSECT RESULTS

Area:	Red River WA
Date of study:	08/17/04
Transect Number:	2
Investigators:	pa
Covertype:	CFW
Transect Type	point intercept
Unit of measure:	feet
Interval:	5
Sample unit size:	100
Height unit of measure:	feet

	GPS COORDINATES		Mag AZ	Length
Start	625117	5066018	330	300
Turning Pt.	625094	5066115	360	300
Turning Pt.				
Turning Pt.				
End	625122	5066200		600

120 POINTS NEEDED **120** POINTS ENTERED **106** POINTS are BARE

Species	N	% CC	Mean DBH	<4"	%CC	4" to 6"	%CC	6" to 10"	%CC	10" to 20"	%CC	> 20"	%CC	NT	%CC
Lodgepole Pine	**14**	11.7%	No samples	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	14	11.7%

DBH DISTRIBUTION	N	%
Small (<4")	**0**	**0.0%**
Medium (4" - 6")	**0**	**0.0%**
Medium large (6" - 10")	**0**	**0.0%**
Large (10" - 20")	**0**	**0.0%**
Very Large (>20")	**0**	**0.0%**
DBH not taken	**14**	**100.0%**

Overall tree height	
MEAN	**66.0**
MODE	**66**
MAX	**66**
MIN	**66**
ST.DEV	**0.00**
TOTAL CC	**3.33%**

SNAG TRANSECT RESULTS

08/17/04

Area: Red River WA
Date of study: 08/17/04
nsect Number: 01/02/00
Investigators: pa
Covertype: Forested Wetland
Belt width 44 foot
Belt legnth 100 foot
Circular plot size:
Height unit of measure: feet

Belts needed 6

Belts entered 6

	GPS COORDINATES		Mag AZ	Length
Start	625117	5066018	330	300
Turning Pt.	625094	5066115	360	300
Turning Pt.				
Turning Pt.				
End	625122	5066200		600

DBH DISTRIBUTION	BELT 1	BELT 2	BELT 3	BELT 4	BELT 5	BELT 6	BELT 7	BELT 8	BELT 9	BELT 10	TOTAL SNAGS	AVERAGE per BELT
No snags	Sampled	Sampled	No snags	No snags	Sampled	Sampled	Not Sampled	Not Sampled	Not Sampled	Not Sampled		
<4"	0	0	0	0	0	0					0	0.0
> 4" =< 6"	1	0	0	0	1	0					2	0.3
> 6" to 10"	3	1	0	0	2	0					6	1.0
>10" to 20"	3	0	0	0	3	4					10	1.7
> 20"	0	0	0	0	0	1					1	0.2
Not recorded											0	0.0
TOTAL snagss	7	1	0	0	6	5	0	0	0	0	19	3.2

Average height	BELT 1	BELT 2	BELT 3	BELT 4	BELT 5	BELT 6	BELT 7	BELT 8	BELT 9	BELT 10	Average height
No snags	Sampled	Sampled	No snags	No snags	Sampled	Sampled	Not Sampled	Not Sampled	Not Sampled	Not Sampled	
<4"											
> 4" =< 6"	1.00				1.00						1.00
> 6" to 10"	1.00	1.00			1.00						1.00
>10" to 20"	1.00				1.00	1.00					1.00
> 20"						1.00					
Not recorded											

Transect 3 Data Synopsis

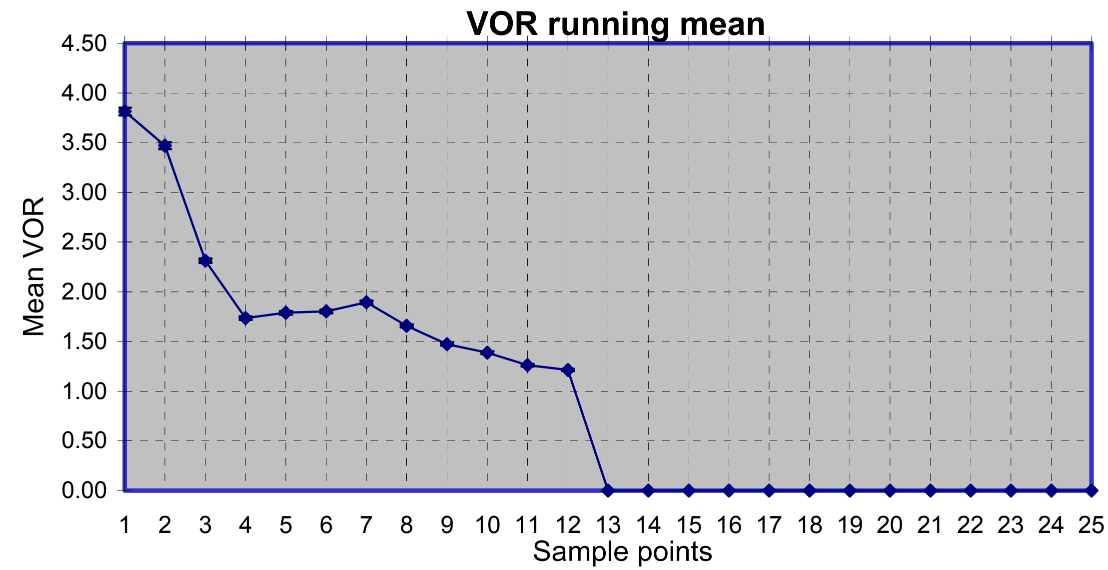
Figure 5. Transect 3 photo point – August 2004.

VOR POINT RESULTS

	GPS COORDINATES		Mag AZ	Length
Start	625024	5066282	14	300
Turning Pt.				
Turning Pt.				
Turning Pt.				
End	625070	5066361	Total Length	300

Area: Red River
Date of study: 08/17/04
Transect Number: 3
Investigators: Ashley (recorder)

Covertype: Wet meadow
Unit of measure: feet
Interval: 25
Number of points: 12
Sample unit size: indep.
Height unit of measure: dec.



12 OF **12** Sample points

MICROPLOT RESULTS

Area: Red River
Date of study: 08/17/04
Transect Number: 3
Investigators: Ashley (recorde

Covertype: Wet meadow
Transect Type Line intercept
Unit of measure: feet
Interval: independent
Number of plots 12

GPS COORDINATES		
Start	625024	5066282
Turning Point		
Turning Point		
Turning Point		
End	625070	5066361

Microplot Data: **12** **PLOTS NEEDED** **12** **PLOTS ENTERED** **0** **PLOTS BARE**

Microplot frame size: **0.10m²** **Mean Veg height** **4.4** **10ths feet**

Plot interval: **25'** **% CC TOTAL** **92.1%**

			GRASS % CC	FORB % CC
%CC	Emerg. Herb cvr.	**92.1%**		
%CC	------			
%CC	------			
%CC	------			

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TOTAL %cc Grass **0.0%** **TOTAL %cc Forbs** **0.0%** **TOT**

Transect 4 Data Synopsis

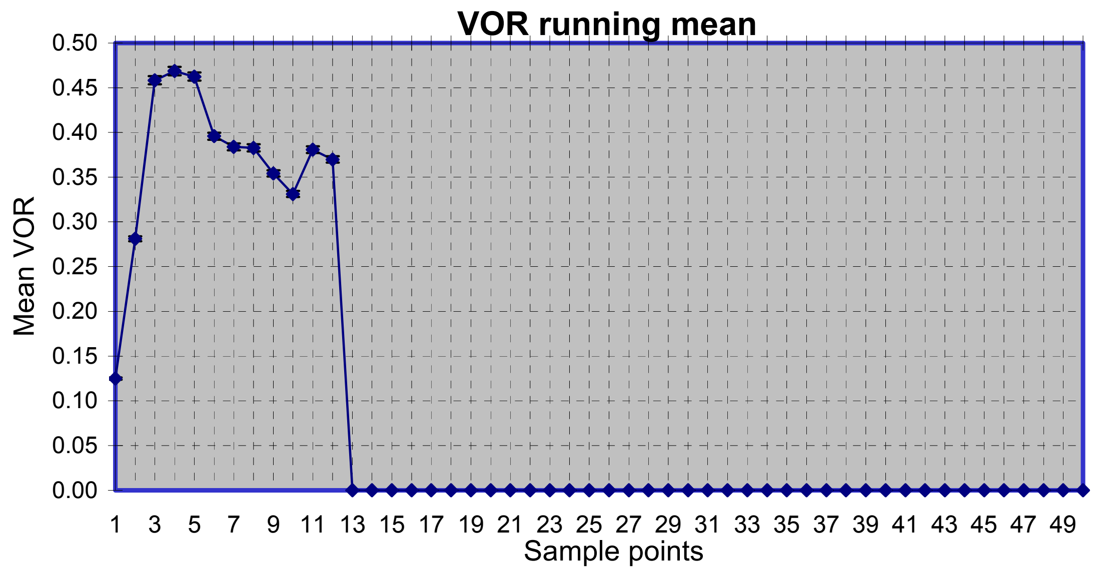
Figure 6. Transect 4 photo point - August 2004.

VOR POINT RESULTS

	GPS COORDINATES		Mag AZ	Length
Start	625117	5066540	353	300
Turning Pt.				
Turning Pt.				
Turning Pt.				
End	625127	5066630	Total Length	300

Area: Red River WA
Date of study: 08/17/04
Transect Number: 4
Investigators: Ashley (recorder)

Covertype: Wet meadow
Unit of measure: feet
Interval: 25
Number of points: 12
Sample unit size: indep.
Height unit of measure: decimeter



12 OF **12** Sample points

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MICROPLOT RESULTS

Area: Red River WA
Date of study: 08/17/04
Transect Number: 4
Investigators: Ashley (recorde

Covertype: Wet meadow
Transect Type line intercept
Unit of measure: feet
Interval: Independent
Number of plots 12

	GPS COORDINATES	
Start	625117	5066540
Turning Point		
Turning Point		
Turning Point		
End	625127	5066630

Microplot Data: 12 **PLOTS NEEDED** 12 **PLOTS ENTERED** 0 **PLOTS BARE**

Microplot frame size: 0.10m sq. **Mean Veg height** 4.7 **10ths/ft**

Plot interval: 25' **% CC TOTAL** 87.9%

			GRASS % CC	FORB % CC
%CC	Emerg. Herb. Cvr.	87.9%		
%CC	- - - - - -			
%CC	- - - - - -			
%CC	- - - - - -			
			TOTAL %cc Grass 0.0%	TOTAL %cc Forbs 0.0%

labitats & Wildlife **TOT**

Transect 5 Data Synopsis

Figure 7. Transect 5 photo point - August 2005.

MICROPLOT RESULTS

Area:	Red River WA	**Covertype:**	Rip. shrub
Date of study:	08/17/04	**Transect Type**	Line Intercept
Transect Number:	5	**Unit of measure:**	Feet
Investigators:	Ashley (recorde	**Interval:**	Independent
		Number of plots	36

GPS COORDINATES		
Start	624942	5066588
Turning Point		
Turning Point		
Turning Point		
End	625008	5066733

Microplot Data: 36 **PLOTS NEEDED** 36 **PLOTS ENTERED** 2 **PLOTS BARE**

Microplot frame size: 0.10m sq. **Mean Veg height** 5.3 **10ths/ft**

Plot interval: 25' **% CC TOTAL** 78.3%

			GRASS % CC	FORB % CC
%CC	Emerg. Herb. Cvr.	78.3%		
%CC	------			
%CC	------			
%CC	------			
			TOTAL %cc Grass 0.0%	TOTAL %cc Forbs 0.0%

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Shrub cover was 0.00 percent on Transect 5.

Transect 5A Data Synopsis

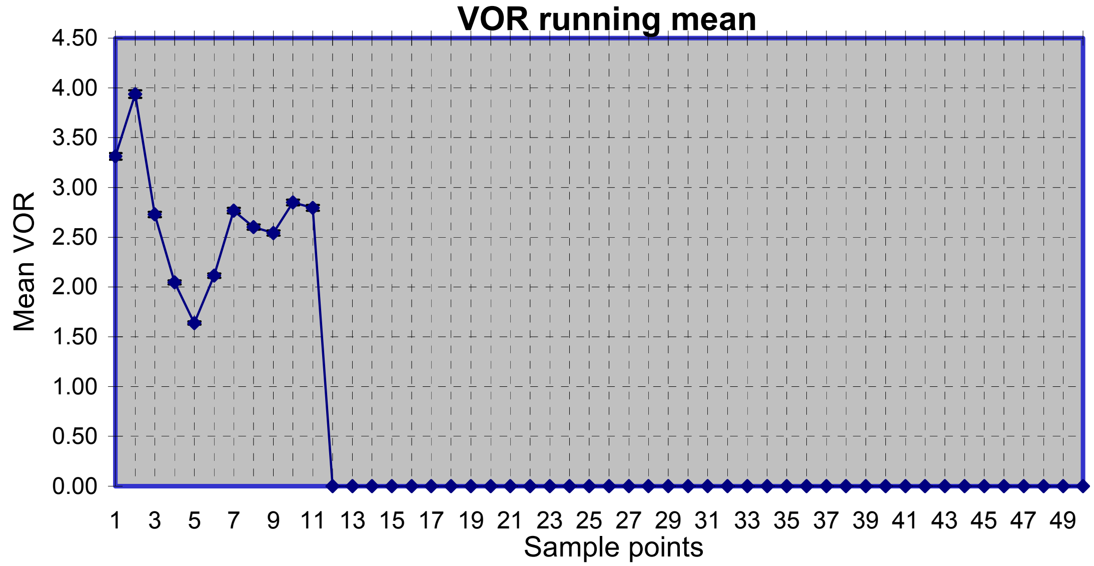
Figure 8. Transect 5A photo point - August 2004.

VOR POINT RESULTS

	GPS COORDINATES		Mag AZ	Length
Start	624942	5066588	206	300
Turning Pt.				
Turning Pt.				
Turning Pt.				
End	624879	5066531	Total Length	300

Area: Red River WA
Date of study: 08/17/04
Transect Number: 005A
Investigators: Ashley (recorder)

Covertype: Wet Meadow
Unit of measure: Feet
Interval: 25
Number of points: 11
Sample unit size: Indep.
Height unit of measure: 10ths/ft



11 OF **11** Sample points

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MICROPLOT RESULTS

Area: Red River WA
Date of study: 08/17/04
Transect Number: 005A
Investigators: Ashley (recorde

Covertype: Wet meadow
Transect Type Line intercept
Unit of measure: Feet
Interval: Independent
Number of plots 11

	GPS COORDINATES	
Start	624942	5066588
Turning Point		
Turning Point		
Turning Point		
End	624879	5066531

Microplot Data: 11 **PLOTS NEEDED** 11 **PLOTS ENTERED** 0 **PLOTS BARE**

Microplot frame size: **0.10m sq.** **Mean Veg height** **9.1** **10ths/ft**

Plot interval: **25'** **% CC TOTAL** **90.9%**

		GRASS % CC	FORB % CC
%CC Emerg. Herb. Veg.	**90.9%**		
%CC ------			
%CC ------			
%CC ------			
		TOTAL %cc Grass 0.0%	**TOTAL %cc Forbs 0.0%**

labitats & Wildlife **TOT**

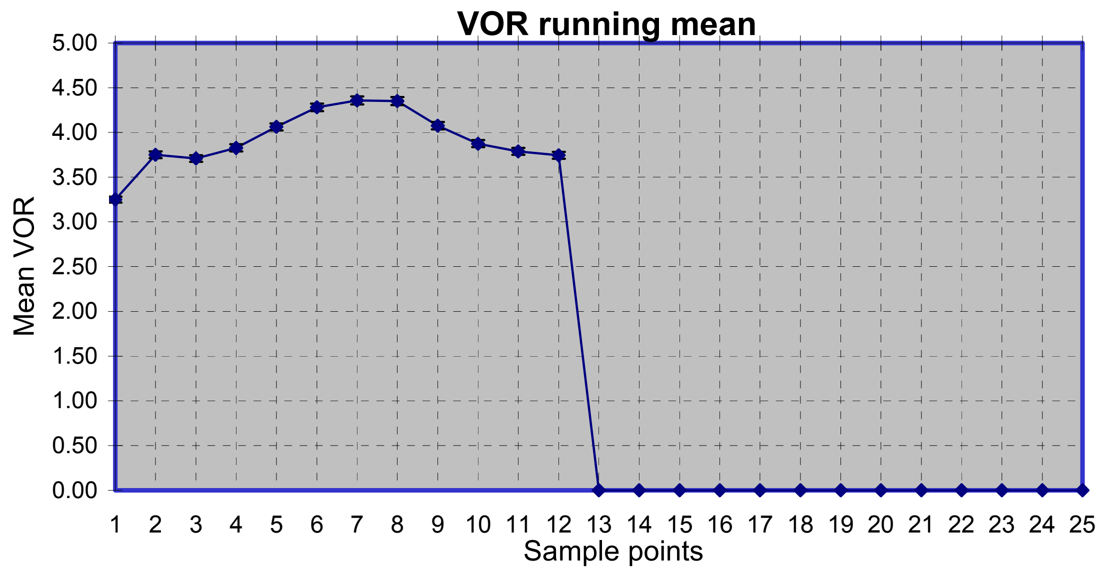
Figure 9. Transect 5B photo point - August 2004.

VOR POINT RESULTS

	GPS COORDINATES		Mag AZ	Length
Start	624863	5066664	260	300
Turning Pt.				
Turning Pt.				
Turning Pt.				
End	624863	5066663	Total Length	300

Area: Red River WA
Date of study: 08/17/04
Transect Number: 005B
Investigators: Ashley (recorder)

Covertype: Wet Meadow
Unit of measure: Feet
Interval: 25'
Number of points: 12
Sample unit size: indep.
Height unit of measure: dec.



12 OF **12** Sample points

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Transect 5C Data Synopsis

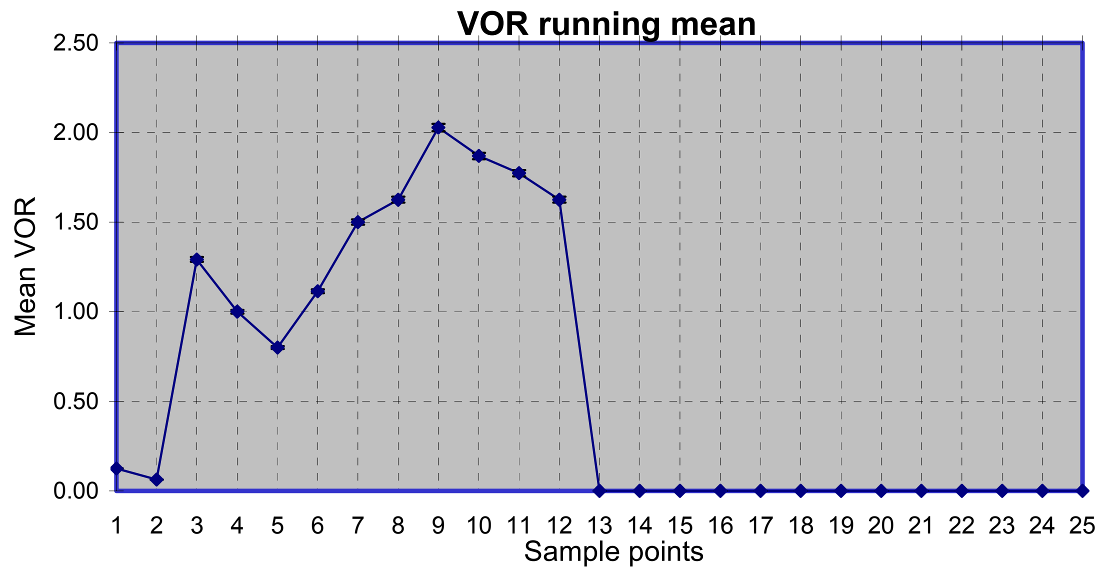
Figure 10. Transect 5C photo point.

VOR POINT RESULTS

	GPS COORDINATES		Mag AZ	Length
Start	625008	5066733	260	300
Turning Pt.				
Turning Pt.				
Turning Pt.				
End	624913	5066745	Total Length	300

Area: Red River WA
Date of study: 08/17/04
Transect Number: 005C
Investigators: ashley (recorder)

Covertype: Wet meadow
Unit of measure: Feet
Interval: 25'
Number of points: 12
Sample unit size: Indep.
Height unit of measure: dec.



12 OF **12** Sample points

MICROPLOT RESULTS

Area: Red River WA
Date of study: 08/17/04
Transect Number: 005C
Investigators: ashley (recorde

Covertype:
Transect Type
Unit of measure: Feet
Interval: Independent
Number of plots 11

	GPS COORDINATES	
Start	625008	5066733
Turning Point		
Turning Point		
Turning Point		
End	624913	5066745

Microplot Data: 11 **PLOTS NEEDED** 11 **PLOTS ENTERED** 0 **PLOTS BARE**

Microplot frame size: **0.10m²** **Mean Veg height** **7.8** **10ths/ft**

Plot interval: **25'** **% CC TOTAL** **93.2%**

		GRASS % CC	FORB % CC
%CC Emerg. Herb. Veg.	**93.2%**		
%CC ------			
%CC ------			
%CC ------			

Habitats & Wildlife

TOTAL %cc Grass **0.0%** **TOTAL %cc Forbs** **0.0%** **TOT**

Transect 7 Data Synopsis

Figure 11. Transect 7 photo point - August 2004.

SHRUB INTERCEPT												
Project:	Red River WA			Transect#:		7	Date:	17-Aug-04		Recorder	Ashley	
Sample	Species		Species		Species		Species		Species		Species	
Unit	Aspen		Service Berry		Lodgepole Pine		E. Spruce		Alder			
	Intercept	Height	Intercept	Height	Intercept	Height	Intercept	Height	Intercept	Height	Intercept	Height
Mean	1.6%	7.3	0.3%	3.1	0.8%	3.9	0.4%	7.0	0.3%	4.8	0.0%	0.0
Mean height measured in feet												

BASAL AREA									
Project:	Red River WA		Transect #:	7	Date:	17-Aug-04	Recorder:	Ashley	
		Transect Length							
Sample Unit	Mean BA	300 feet	400 feet	500 feet	600 feet	700 feet	800 feet	900 feet	1,000 feet
0' - 100'								13	
100 '- 200'								16	
200' - 300'								6	
300' - 400'	Mean BA	0.0						3	
400' - 500'		Mean BA	0.0					6	
500' - 600'			Mean BA	0.0				8	
600' - 700'				Mean BA	0.0			7	
700' - 800'					Mean BA	0.0		4	
800' - 900'						Mean BA	0.0	6	
900' - 1,000'							Mean BA	76.7	
								Mean BA	0.0

TREE TRANSECT RESULTS

Area: Red River WA
Date of study: 08/17/04
Transect Number: 7
Investigators: Ashley (recorder)
Covertype: Mixed Con. For.
Transect Type Point Intercept
Unit of measure: Feet
Interval: 5'

Sample unit size: 100'
Height unit of measure: Feet

	GPS COORDINATES		Mag AZ	Length
Start	624553	5066743	247	300
Turning Pt.	624466	5066738	330	300
Turning Pt.	624442	5066830	285	300
Turning Pt.				
End	624371	5066875	Total Length	900

180 POINTS NEEDED **180 POINTS ENTERED** **123 POINTS are BARE**

Species	N	% CC	Mode DBH	<4"	%CC	4" to 6"	%CC	6" to 10"	%CC	10" to 20"	%CC	> 20"	%CC	NT	%CC
Aspen	14	7.8%	<4	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	14	7.8%
Lodgepole pine	43	23.9%	<4	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	43	23.9%

DBH DISTRIBUTION	N	%
Small (<4")	0	0.0%
Medium (4" - 6")	0	0.0%
Medium large (6" - 10")	0	0.0%
Large (10" - 20")	0	0.0%
Very Large (>20")	0	0.0%
DBH not taken	57	100.0%

Overall tree height	
MEAN	55.8
MODE	50
MAX	63
MIN	50
ST.DEV	6.75
TOTAL CC	31.67%

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SNAG TRANSECT RESULTS

Area: Red River WA
Date of study: 08/17/04
Transect Number: 7
Investigators: Ashley (recorder)
Covertype: Con. For. All Snags
Belt width 44' Feet
Belt legnth 100' Feet
Circular plot size:
Height unit of measure: Feet

	GPS COORDINATES		Mag AZ	Length
Start	624553	5066743	247	300
Turning Pt.	624466	5066738	330	300
Turning Pt.	624442	5066830	285	300
Turning Pt.				
End	624371	5066875	Total Length	900

Plots needed 0 **Plots entered** 9

DBH DISTRIBUTION	PLOT 1	PLOT 2	PLOT 3	PLOT 4	PLOT 5	PLOT 6	PLOT 7	PLOT 8	PLOT 9	PLOT 10	TOTAL SNAGS	AVERAGE per BELT
No snags	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled	Not Sampled		
<4"	0	0	0	0	0	0	0	0	0		0	N/A
> 4" =< 6"	0	1	0	0	0	0	0	0	0		1	0.1
> 6" to 10"	0	0	0	2	0	1	0	0	0		3	0.3
>10" to 20"	3	7	6	4	0	0	0	2	6		28	3.1
> 20"	0	2	0	0	1	0	0	0	0		3	0.3
Not recorded	0	0	0	0	0	0	0	0	0		0	N/A
TOTAL snags	3	10	6	6	1	1	0	2	6		35	3.9

AVERAGE HEIGHT	PLOT 1	PLOT 2	PLOT 3	PLOT 4	PLOT 5	PLOT 6	PLOT 7	PLOT 8	PLOT 9	PLOT 10	Weighted average height
No snags	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled	Not Sampled	
<4"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		N/A
> 4" =< 6"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		N/A
> 6" to 10"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		N/A
>10" to 20"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		N/A
> 20"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00 Feet
Not recorded	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		N/A
Mean height	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!	0.00	0.00		0.00 Feet

SNAG TRANSECT RESULTS

Area: Red River WA
Date of study: 08/17/04
Transect Number: 7
Investigators: Ashley (recorder)
Covertype: Con. For. True Snags
Belt width 44' Feet
Belt legnth 100' Feet
Circular plot size:
Height unit of measure: Feet

	GPS COORDINATES		Mag AZ	Length
Start	624553	5066743	247	300
Turning Pt.	624466	5066738	330	300
Turning Pt.	624442	5066830	285	300
Turning Pt.				
End	624371	5066875	Total Length	900

Plots needed 0 **Plots entered** 9

DBH DISTRIBUTION	PLOT 1	PLOT 2	PLOT 3	PLOT 4	PLOT 5	PLOT 6	PLOT 7	PLOT 8	PLOT 9	PLOT 10	TOTAL SNAGS	AVERAGE per BELT
No snags	Sampled	Sampled	No snags	No snags	Sampled	Sampled	Sampled	Sampled	Sampled	Not Sampled		
<4"	0	0	0	0	0	0	0	0	0		0	N/A
> 4" =< 6"	0	0	0	0	0	0	0	0	0		0	N/A
> 6" to 10"	0	0	0	0	0	1	0	0	0		1	0.1
>10" to 20"	3	4	0	0	0	0	0	2	3		12	1.3
> 20"	0	0	0	0	1	0	0	0	0		1	0.1
Not recorded	0	0	0	0	0	0	0	0	0		0	N/A
TOTAL snags	3	4	0	0	1	1	0	2	3		14	1.6

AVERAGE HEIGHT	PLOT 1	PLOT 2	PLOT 3	PLOT 4	PLOT 5	PLOT 6	PLOT 7	PLOT 8	PLOT 9	PLOT 10	Weighted average height	
No snags	Sampled	Sampled	No snags	No snags	Sampled	Sampled	Sampled	Sampled	Sampled	Not Sampled		
<4"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		N/A	
> 4" =< 6"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		N/A	
> 6" to 10"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		N/A	
>10" to 20"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		N/A	
> 20"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	Feet
Not recorded	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		N/A	
Mean height	0.00	0.00	N/A	N/A	0.00	0.00	#DIV/0!	0.00	0.00		0.00	Feet

Transect 8 Data Synopsis

Figure 12. Transect 8 photo point - August 2004.

SHRUB INTERCEPT												
Project:	Red River		Transect#:		8	Date:	17-Aug-04		Recorder	Ashley		
Sample	Species		Species		Species		Species		Species		Species	
Unit	Service Berry		Huckleberry		Spirea		Unknown		Kinickinick		Oregon Grape	
	Intercept	Height	Intercept	Height	Intercept	Height	Intercept	Height	Intercept	Height	Intercept	Height
Mean	1.5%	3.1	1.2%	4.6	0.1%	1.1	0.4%	1.4	0.1%	0.4	0.1%	0.4
Mean height is in feet												

BASAL AREA									
Project:	Red River		Transect #:	8	Date:	17-Aug-04	Recorder:	Ashley	
		Transect Length							
Sample Unit	Mean BA	300 feet	400 feet	500 feet	600 feet	700 feet	800 feet	900 feet	1,000 feet
0' - 100'					5				
100 '- 200'					8				
200' - 300'					13				
300' - 400'	Mean BA	0			12				
400' - 500'		Mean BA	0		2				
500' - 600'			Mean BA	0	1				
600' - 700'				Mean BA	68.33				
700' - 800'					Mean BA	0			
800' - 900'						Mean BA	0		
900' - 1,000'							Mean BA	0	
								Mean BA	0

TREE TRANSECT RESULTS

Area: Red River WA
Date of study: 08/17/04
Transect Number: 8
Investigators: Ashley (recorder)
Covertype: Conifer Forest
Transect Type Point Intercept
Unit of measure: Feet
Interval: 5'

Sample unit size: 100'
Height unit of measure: Feet

	GPS COORDINATES		Mag AZ	Length
Start	625086	5066700	5	550
Turning Pt.				
Turning Pt.				
Turning Pt.				
End	625136	5066864	Total Length	550

110 POINTS NEEDED **110 POINTS ENTERED** **89 POINTS are BARE**

Species	N	% CC	Mode DBH	<4"	%CC	4" to 6"	%CC	6" to 10"	%CC	10" to 20"	%CC	> 20"	%CC	NT	%CC
Lodgepole pine	21	19.1%	<4	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	21	19.1%

DBH DISTRIBUTION	N	%
Small (<4")	0	0.0%
Medium (4" - 6")	0	0.0%
Medium large (6" - 10")	0	0.0%
Large (10" - 20")	0	0.0%
Very Large (>20")	0	0.0%
DBH not taken	21	100.0%

Overall tree height	
MEAN	69.8
MODE	72
MAX	75
MIN	65
ST.DEV	4.55
TOTAL CC	19.09%

Habitats & Wildlife

SNAG TRANSECT RESULTS

Area: Red River WA
Date of study: 08/17/04
Transect Number: 8
Investigators: Ashley (recorder)
Covertype: Con. For. True snags
Belt width 44' Feet
Belt legnth 100' Feet
Circular plot size:
Height unit of measure: Feet

	GPS COORDINATES		Mag AZ	Length
Start	625086	5066700	5	550
Turning Pt.				
Turning Pt.				
Turning Pt.				
End	625136	5066864	Total Length	550

Plots needed 0 **Plots entered** 6

DBH DISTRIBUTION	PLOT 1	PLOT 2	PLOT 3	PLOT 4	PLOT 5	PLOT 6	PLOT 7	PLOT 8	PLOT 9	PLOT 10	TOTAL SNAGS	AVERAGE per BELT
No snags	No snags	No snags	No snags	Sampled	Sampled	No snags	Not Sampled	Not Sampled	Not Sampled	Not Sampled		
<4"	0	0	0	0	0	0					0	N/A
> 4" =< 6"	0	0	0	0	0	0					0	N/A
> 6" to 10"	0	0	0	0	0	0					0	N/A
>10" to 20"	0	0	0	2	1	0					3	0.5
> 20"	0	0	0	0	0	0					0	N/A
Not recorded	0	0	0	0	0	0					0	N/A
TOTAL snags	0	0	0	2	1	0					3	0.5

Transect 10 Data Synopsis

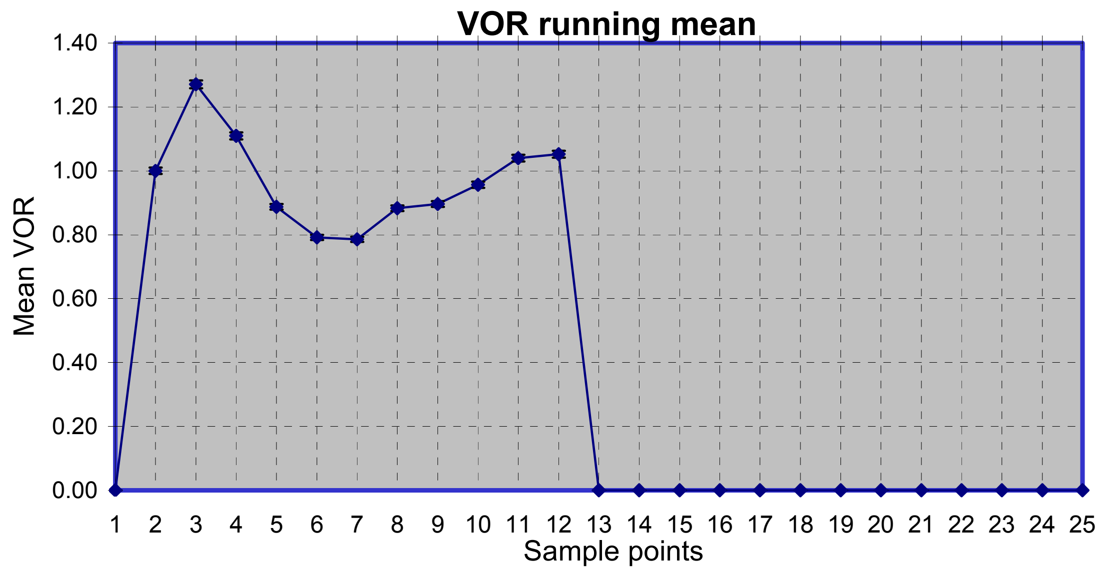
Figure 13. Transect 10 photo point - August 2004.

VOR POINT RESULTS

	GPS COORDINATES		Mag AZ	Length
Start	624968	5067046	67	300
Turning Pt.				
Turning Pt.				
Turning Pt.				
End	625061	5067039	Total Length	300

Area: Red River WA
Date of study: 08/17/04
Transect Number: 10
Investigators: Ashley (recorder)

Covertype: Wet meadow
Unit of measure: Feet
Interval: 25'
Number of points: 12
Sample unit size: Indep.
Height unit of measure: dec.



12 OF **12** Sample points

Habitats & Wildlife

MICROPLOT RESULTS

Area: Red River WA
Date of study: 08/17/04
Transect Number: 10
Investigators: Ashley (recorde

Covertype: Wet meadow
Transect Type
Unit of measure: Feet
Interval: Independent
Number of plots 12

	GPS COORDINATES		Mag AZ	Length
Start	624968	5067046	67	300
Turning Point				
Turning Point				
Turning Point				
End	625061	5067039	Total Length	300

Microplot Data: 12 **PLOTS NEEDED** 12 **PLOTS ENTERED** 0 **PLOTS BARE**

Microplot frame size: 0.10m² **Mean Veg height** 4.5 **10ths/ft**

Plot interval: 25' **% CC TOTAL** 96.3%

			GRASS % CC	FORB % CC	EXOTIC % CC
%CC	Emerg. Herb. Cvr.	96.3%			
%CC	------				
%CC	------				
%CC	------				
			TOTAL %cc Grass 0.0%	TOTAL %cc Forbs 0.0%	TOTAL %cc Exotic 0.0%

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Transect 13 Data Synopsis

Figure 14. Transect 13 photo point - August 2004.

MICROPLOT RESULTS

Area: Red River WA
Date of study: 08/18/04
Transect Number: 13
Investigators: Ashley (recorde

Covertype: Rip. Shrub
Transect Type Line Intercept
Unit of measure: Feet
Interval: Indep.
Number of plots 36

	GPS COORDINATES		Mag AZ	Length
Start	624796	5067548	132	900
Turning Point				
Turning Point				
Turning Point				
End	624640	5067414	Total Length	900

Microplot Data: 36 **PLOTS NEEDED** 36 **PLOTS ENTERED** 0 **PLOTS BARE**

Microplot frame size: 0.10m² **Mean Veg height** 5.9 **10ths/ft**

Plot interval: 25' **% CC TOTAL** 82.1%

		GRASS % CC	FORB % CC	EXOTIC % CC
%CC Emerg. Herb. Cvr.	82.1%			
%CC ------				
%CC ------				
%CC ------				
		TOTAL %cc Grass 0.0%	TOTAL %cc Forbs 0.0%	TOTAL %cc Exotic 0.0%

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SHRUB INTERCEPT						
Project:	Red River WA			Transect#:		13
Sample	Species		Species		Species	
Unit	Willow spp.		R.O.Dogwood		Alder	
	Intercept	Height	Intercept	Height	Intercept	Height
Mean	4.9%	1.6	0.2%	1.0	0.01%	1.1
Tran. Mean	5.13%	1.23	Height is in feet			

Transect 13A Data Synopsis

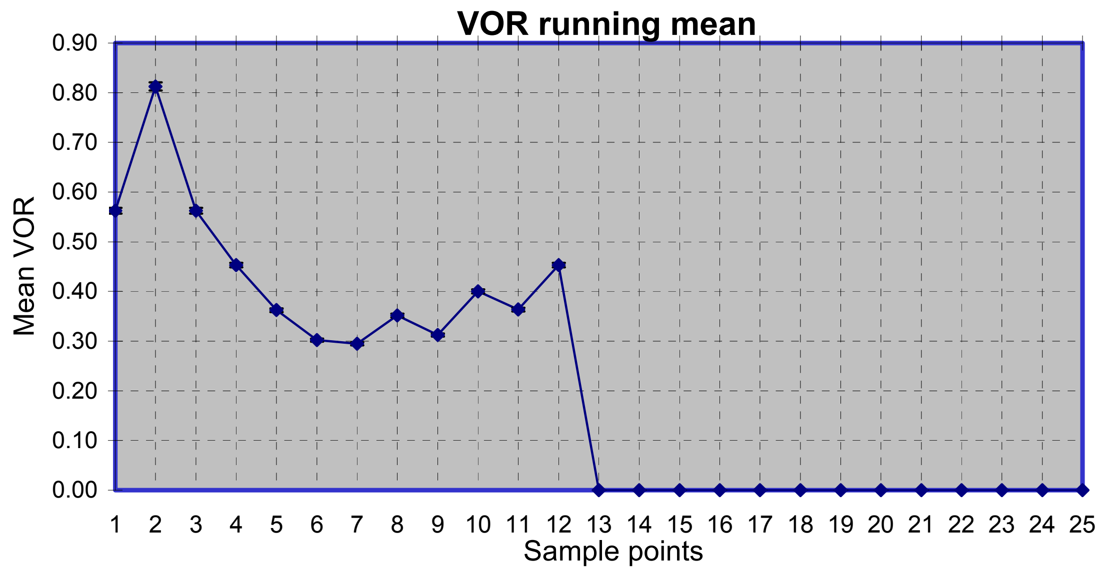
Figure 15. Transect 13A photo point - August 2004.

VOR POINT RESULTS

	GPS COORDINATES		Mag AZ	Length
Start	624796	5067548	50	300
Turning Pt.				
Turning Pt.				
Turning Pt.				
End	624877	5067588	Total Length	300

Area: Red River WA
Date of study: 08/18/04
Transect Number: 13A
Investigators: Ashley (recorder)

Covertype: Wet Meadow
Unit of measure: Feet
Interval: 25'
Number of points: 12
Sample unit size: Indep.
Height unit of measure: dec.



12 OF **12** Sample points

Habitats & Wildlife

MICROPLOT RESULTS

Area: Red River WA
Date of study: 08/18/04
Transect Number: 13A
Investigators: Ashley (recorde

Covertype: wet meadow
Transect Type Line Intercept
Unit of measure: Feet
Interval: Indep.
Number of plots 12

	GPS COORDINATES		Mag AZ	Length
Start	624796	5067548	50	300
Turning Point				
Turning Point				
Turning Point				
End	624877	5067588	Total Length	300

Microplot Data: 12 **PLOTS NEEDED** 12 **PLOTS ENTERED** 0 **PLOTS BARE**

Microplot frame size: 0.10m² **Mean Veg height** 5.3 **10ths/ft.**

Plot interval: 25' **% CC TOTAL** 68.3%

		GRASS % CC	FORB % CC	EXOTIC % CC
%CC Emerg. Herb. Cvr.	68.3%			
%CC ------				
%CC ------				
%CC ------				
		TOTAL %cc Grass 0.0%	TOTAL %cc Forbs 0.0%	TOTAL %cc Exotic 0.0%

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Transect 13B Data Synopsis

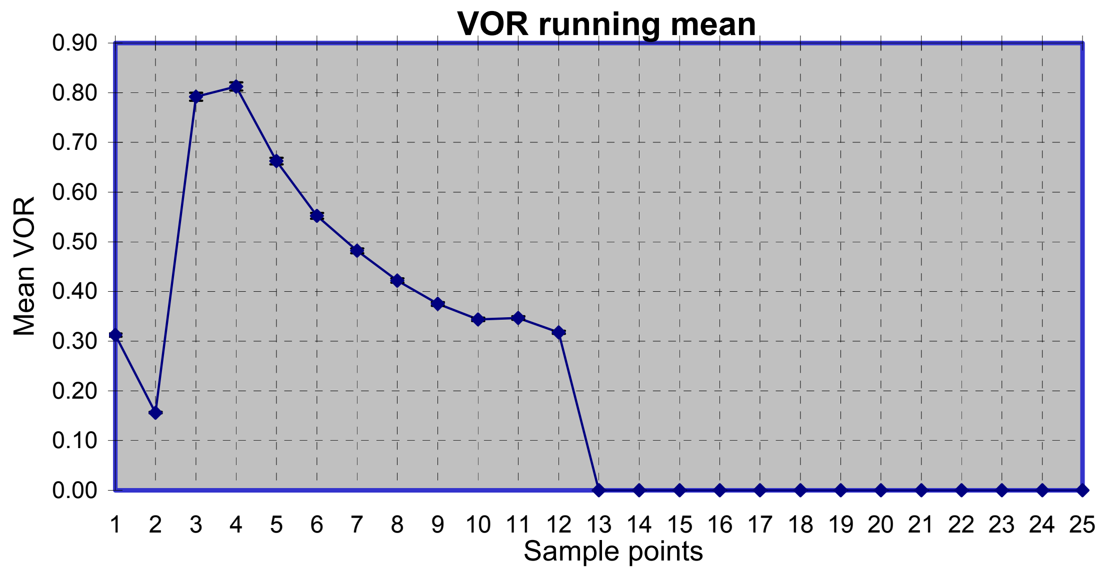
Figure 16. Transect 13B photo point - August 2004.

VOR POINT RESULTS

	GPS COORDINATES		Mag AZ	Length
Start	624697	5067475	154	300
Turning Pt.				
Turning Pt.				
Turning Pt.				
End	624706	5067392	Total Length	300

Area: Red River WA
Date of study: 08/18/04
Transect Number: 013B
Investigators: Ashley

Covertype: Wet meadow
Unit of measure: Feet
Interval: 25'
Number of points: 12
Sample unit size: Indep.
Height unit of measure: dec.



12 OF 12 Sample points

Habitats & Wildlife

MICROPLOT RESULTS

Area: Red River WA
Date of study: 08/18/04
Transect Number: 013B
Investigators: Ashley

Covertype: Wet meadow
Transect Type Line intercept
Unit of measure: Feet
Interval: Indep.
Number of plots 12

	GPS COORDINATES		Mag AZ	Length
Start	624697	5067475	154	300
Turning Point				
Turning Point				
Turning Point				
End	624706	5067392	Total Length	300

Microplot Data: 12 **PLOTS NEEDED** 12 **PLOTS ENTERED** 1 **PLOTS BARE**

Microplot frame size: 0.10m² **Mean Veg height** 4.7 **10ths/ft**

Plot interval: 25' **% CC TOTAL** 85.0%

			GRASS % CC	FORB % CC	EXOTIC % CC
%CC	Emerg. Herb. Cvr.	85.0%			
%CC	------				
%CC	------				
%CC	------				
			TOTAL %cc Grass 0.0%	**TOTAL %cc Forbs** 0.0%	**TOTAL %cc Exotic** 0.0%

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Transect 14 Data Synopsis

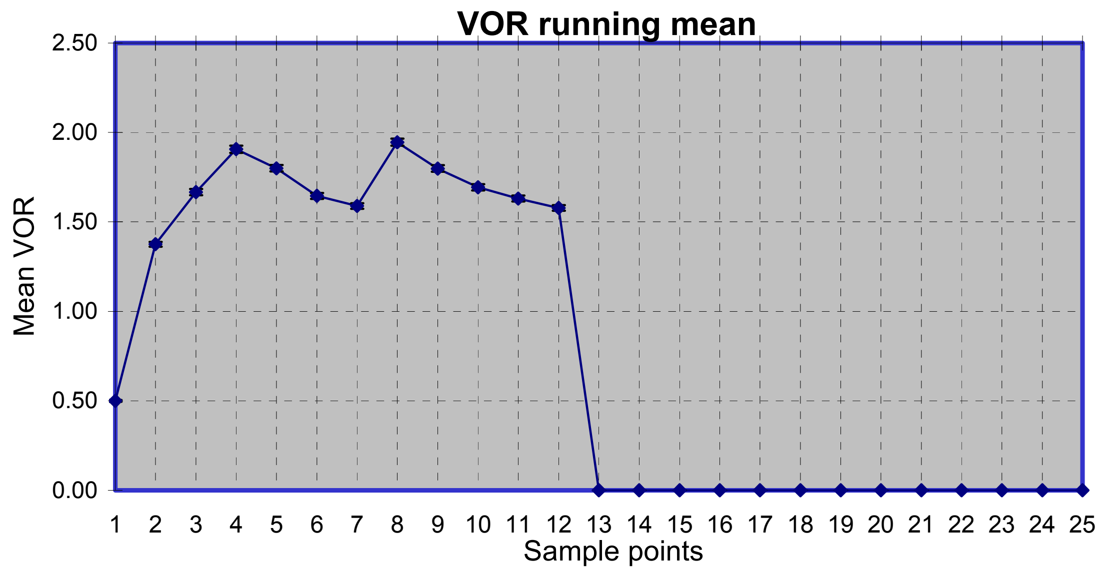
Figure 17. Transect 14 photo point - August 2004.

VOR POINT RESULTS

	GPS COORDINATES		Mag AZ	Length
Start	625028	5067716	300	300
Turning Pt.				
Turning Pt.				
Turning Pt.				
End	624951	5067693	Total Length	300

Area: Red River WA
Date of study: 08/16/04
Transect Number: 14
Investigators: Ashley (recorder)

Covertype: Riparian Shrub
Unit of measure: Feet
Interval: 25'
Number of points: 12
Sample unit size: Indep.
Height unit of measure: dec.



12 OF **12** Sample points

Habitats & Wildlife

MICROPLOT RESULTS

Area: Red River WA
Date of study: 08/16/04
Transect Number: 14
Investigators: Ashley (recorde

Covertype: Wet meadow
Transect Type Line Intercept
Unit of measure: Feet
Interval: Indep.
Number of plots 12

	GPS COORDINATES		Mag AZ	Length
Start	625028	5067716	300	300
Turning Point				
Turning Point				
Turning Point				
End	624951	5067693	Total Length	300

Microplot Data: 12 **PLOTS NEEDED** 12 **PLOTS ENTERED** 0 **PLOTS BARE**

Microplot frame size: 0.10m² **Mean Veg height** 6.6 **10ths/ft**

Plot interval: 25' **% CC TOTAL** 96.7%

		GRASS % CC	FORB % CC	EXOTIC % CC
%CC Emerg. Herb. Cvr.	96.7%			
%CC ------				
%CC ------				
%CC ------				
		TOTAL %cc Grass 0.0%	TOTAL %cc Forbs 0.0%	TOTAL %cc Exotic 0.0%

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SHRUB INTERCEPT												
Project:	Red River			Transect#:		14	Date:	16-Aug-04		Recorder	Ashley	
Sample	Species		Species		Species		Species		Species		Species	
Unit	Alder spp.											
	Intercept	Height	Intercept	Height	Intercept	Height	Intercept	Height	Intercept	Height	Intercept	Height
Mean	1.6%	3.0										

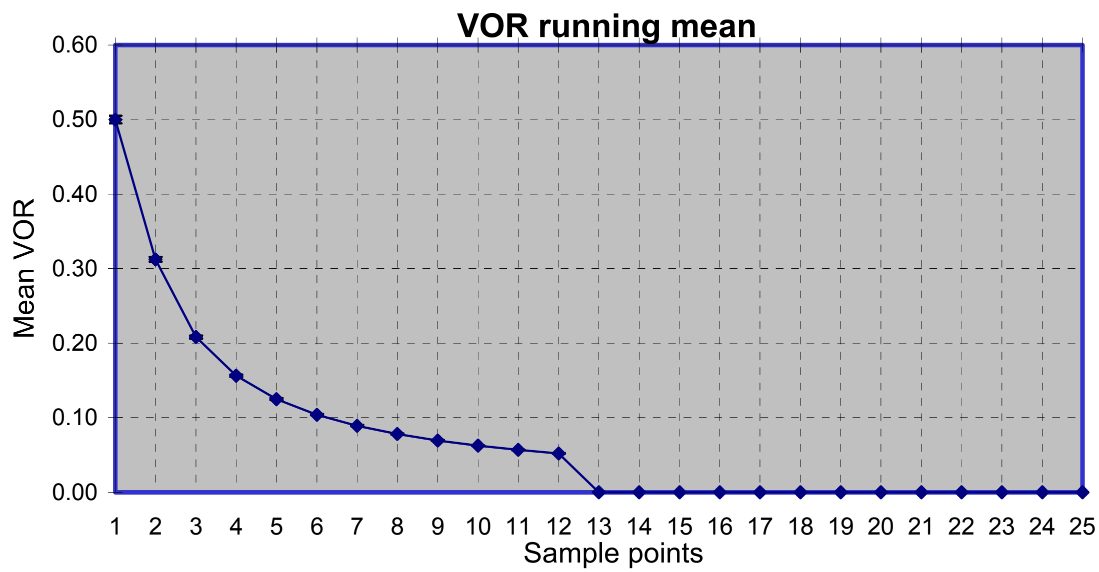
Transect 14A Data Synopsis (Photo not available)

VOR POINT RESULTS

	GPS COORDINATES		Mag AZ	Length
Start	625028	5067716	140	300
Turning Pt.				
Turning Pt.				
Turning Pt.				
End	625080	5067631	Total Length	300

Area: Red River WA
Date of study: 08/16/04
Transect Number: 014A
Investigators: Ashley (recorder)

Covertype: Wet Meadow
Unit of measure: Feet
Interval: 25'
Number of points: 12
Sample unit size: Indep.
Height unit of measure: dec.



12 OF **12** Sample points

Habitats & Wildlife

MICROPLOT RESULTS

Area: Red River WA
Date of study: 08/16/04
Transect Number: 014A
Investigators: Ashley (recorde

Covertype: Wet meadow
Transect Type Line Intercept
Unit of measure: Feet
Interval: Indep.
Number of plots 12

	GPS COORDINATES		Mag AZ	Length
Start	625028	5067716	140	300
Turning Point				
Turning Point				
Turning Point				
End	625080	5067631	Total Length	300

Microplot Data: 12 **PLOTS NEEDED** 12 **PLOTS ENTERED** 0 **PLOTS BARE**

Microplot frame size: 0.10m² **Mean Veg height** 2.7 **10ths/ft**

Plot interval: 25' **% CC TOTAL** 89.6%

		GRASS % CC	FORB % CC	EXOTIC % CC
%CC Emerg. Herb. Cvr.	89.6%			
%CC ------				
%CC ------				
%CC ------				
		TOTAL %cc Grass 0.0%	TOTAL %cc Forbs 0.0%	TOTAL %cc Exotic 0.0%

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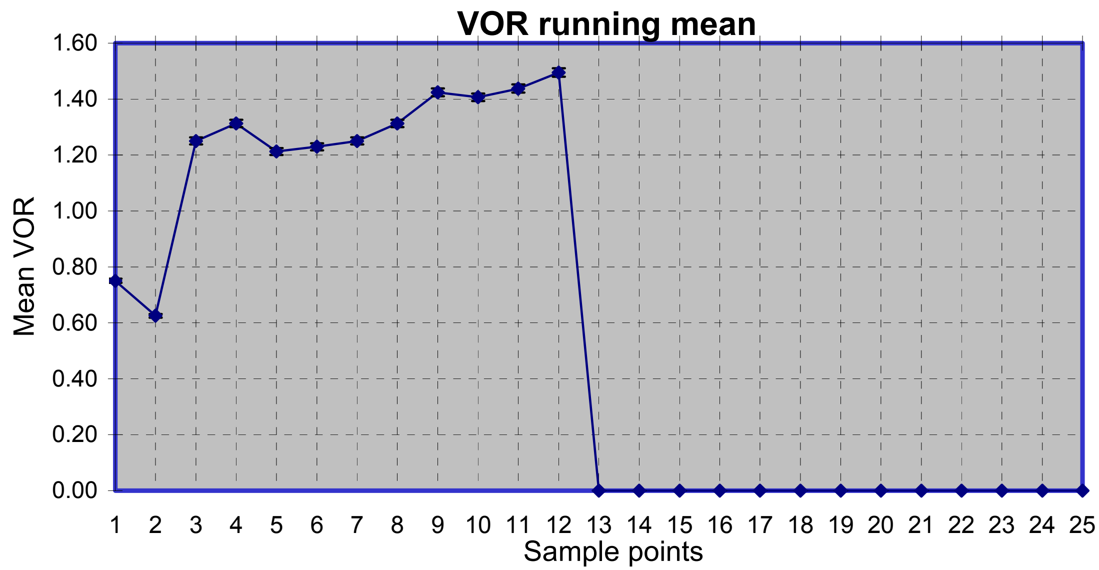
Transect 14B Data Synopsis (Photo not available)

VOR POINT RESULTS

	GPS COORDINATES		Mag AZ	Length
Start	624996	5067700	320	300
Turning Pt.				
Turning Pt.				
Turning Pt.				
End	624966	5067788	Total Length	300

Area: Red River WA
Date of study: 08/16/04
Transect Number: 014B
Investigators: Ashley (recorder)

Covertype: Wet Meadow
Unit of measure: Feet
Interval: 25'
Number of points: 12
Sample unit size: Indep.
Height unit of measure: dec.



12 OF **12** Sample points

MICROPLOT RESULTS

Area: Red River WA
Date of study: 08/16/04
Transect Number: 014B
Investigators: Ashley (recorde

Covertype: Wet Meadow
Transect Type Line Intercept
Unit of measure: Feet
Interval: Indep.
Number of plots 12

	GPS COORDINATES		Mag AZ	Length
Start	624996	5067700	320	300
Turning Point				
Turning Point				
Turning Point				
End	624966	5067788	Total Length	300

Microplot Data: 12 **PLOTS NEEDED** 12 **PLOTS ENTERED** 0 **PLOTS BARE**

Microplot frame size: 0.10m² **Mean Veg height** 7.7 **10ths/ft.**

Plot interval: 25' **% CC TOTAL** 98.8%

			GRASS % CC	FORB % CC	EXOTIC % CC
%CC	Emerg. Herb. Cvr.	98.8%			
%CC	------				
%CC	------				
%CC	------				
			TOTAL %cc Grass 0.0%	TOTAL %cc Forbs 0.0%	TOTAL %cc Exotic 0.0%

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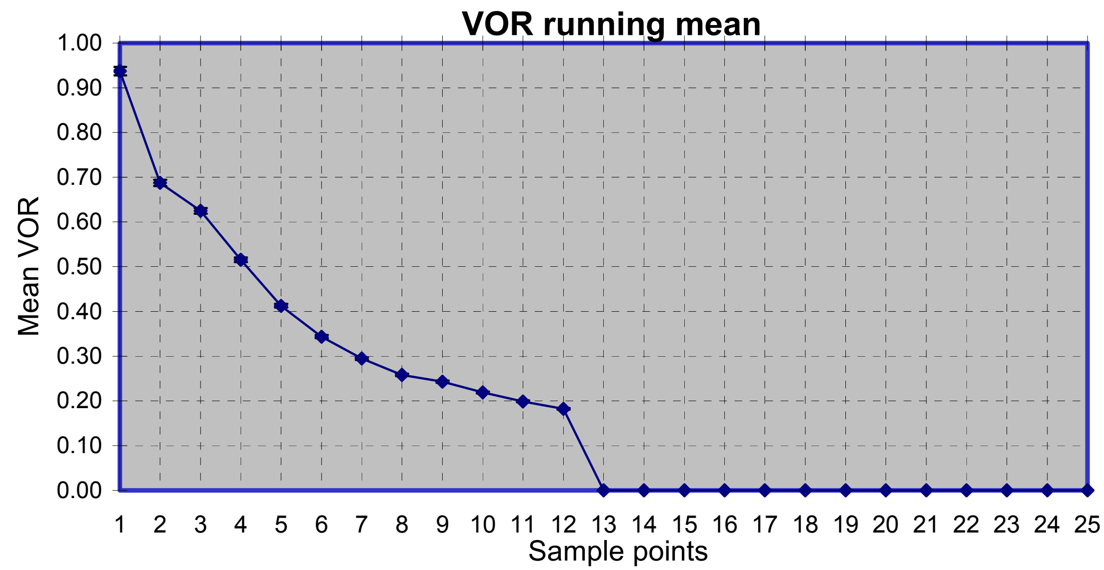
Transect 14C Data Synopsis (Photo not available)

VOR POINT RESULTS

	GPS COORDINATES		Mag AZ	Length
Start	624591	5067693	140	300
Turning Pt.				
Turning Pt.				
Turning Pt.				
End	624984	5067605	Total Length	300

Area: Red River WA
Date of study: 08/16/04
Transect Number: 014C
Investigators: Ashley (recorder)

Covertype: Wet Meadow
Unit of measure: Feet
Interval: 25'
Number of points: 12
Sample unit size: Indep.
Height unit of measure: dec.



12 OF **12** Sample points

Habitats & Wildlife

MICROPLOT RESULTS

Area:	Red River WA	**Covertype:**	Wet Meadow
Date of study:	08/16/04	**Transect Type**	Line Intercept
Transect Number:	014C	**Unit of measure:**	Feet
Investigators:	Ashley (recorde	**Interval:**	Indep.
		Number of plots	12

	GPS COORDINATES		Mag AZ	Length
Start	624591	5067693	140	300
Turning Point				
Turning Point				
Turning Point				
End	624984	5067605	Total Length	300

Microplot Data: 12 **PLOTS NEEDED** 12 **PLOTS ENTERED** 0 **PLOTS BARE**

Microplot frame size: 0.10m² **Mean Veg height** 3.1 **10ths/ft.**

Plot interval: 25' **% CC TOTAL** 90.4%

			GRASS % CC	**FORB % CC**	**EXOTIC % CC**
%CC	Emerg. Herb. Cvr.	**90.4%**			
%CC	------				
%CC	------				
%CC	------				
			TOTAL %cc Grass 0.0%	**TOTAL %cc Forbs** 0.0%	**TOTAL %cc Exotic** 0.0%

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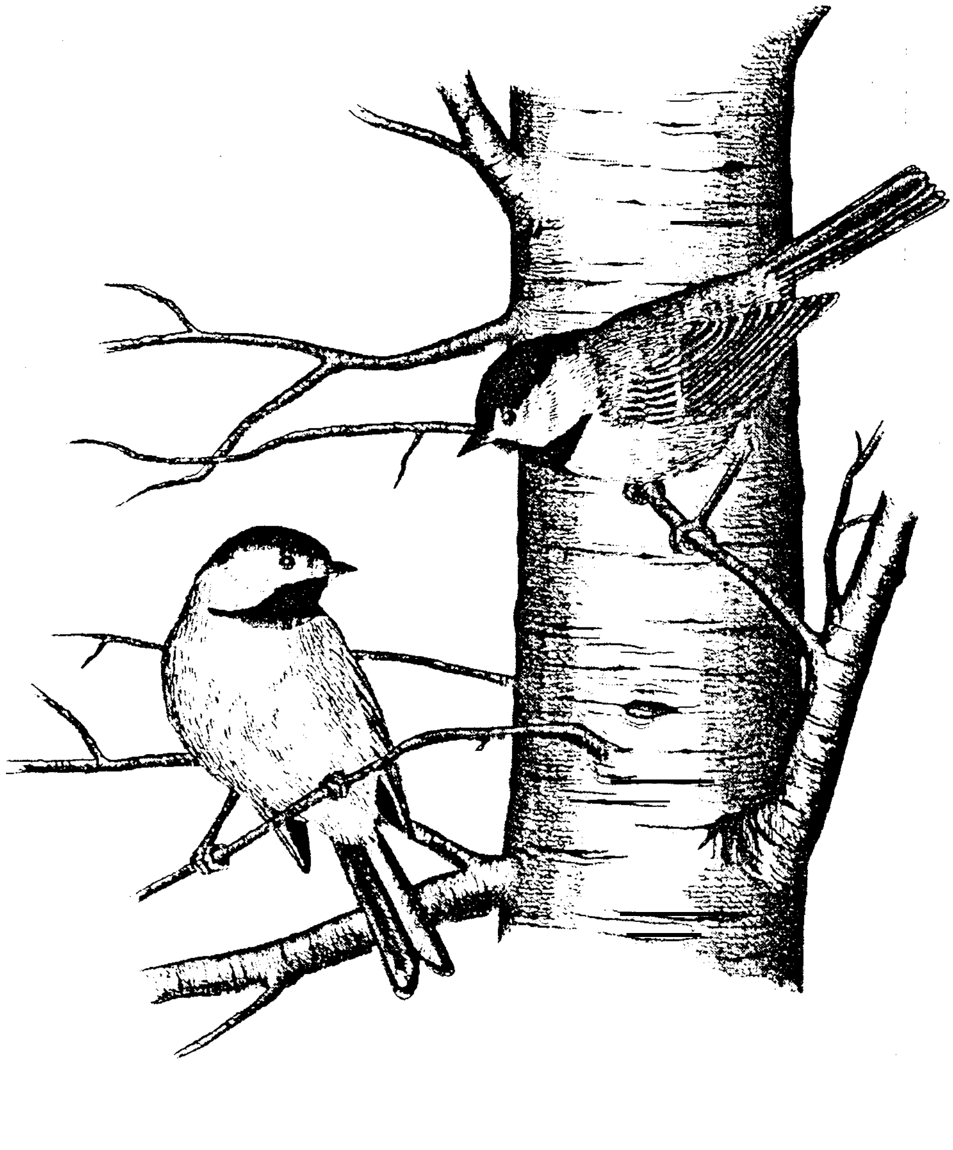
ATTACHMENT 1

(HEP Models)

FWS/OBS-82/10.37
APRIL 1983

HABITAT SUITABILITY INDEX MODELS: BLACK-CAPPED CHICKADEE



Fish and Wildlife Service

U.S. Department of the Interior

This model is designed to be used by the Division of Ecological Services in conjunction with the Habitat Evaluation Procedures.

FWS/OBS-82/10.37
April 1983

HABITAT SUITABILITY INDEX MODELS: BLACK-CAPPED CHICKADEE

by

Richard L. Schroeder
107 N. Hollywood
Fort Collins, CO 80521

Project Officer

R. Charles Solomon
Western Energy and Land Use Team
Drake Creekside Building One
U.S. Fish and Wildlife Service
2627 Redwing Road
Fort Collins, CO 80526

Western Energy and Land Use Team
Division of Biological Services
Research and Development
Fish and Wildlife Service
U.S. Department of the Interior
Washington, DC 20240

PREFACE

This document is part of the Habitat Suitability Index (HSI) Model Series (FWS/OBS-82/10), which provides habitat information useful for impact assessment and habitat management. Several types of habitat information are provided. The Habitat Use Information Section is largely constrained to those data that can be used to derive quantitative relationships between key environmental variables and habitat suitability. The habitat use information provides the foundation for HSI models that follow. In addition, this same information may be useful in the development of other models more appropriate to specific assessment or evaluation needs.

The HSI Model Section documents a habitat model and information pertinent to its application. The model synthesizes the habitat use information into a framework appropriate for field application and is scaled to produce an index value between 0.0 (unsuitable habitat) and 1.0 (optimum habitat). The application information includes descriptions of the geographic ranges and seasonal application of the model, its current verification status, and a listing of model variables with recommended measurement techniques for each variable.

In essence, the model presented herein is a hypothesis of species-habitat relationships and not a statement of proven cause and effect relationships. Results of model performance tests, when available, are referenced. However, models that have demonstrated reliability in specific situations may prove unreliable in others. For this reason, feedback is encouraged from users of this model concerning improvements and other suggestions that may increase the utility and effectiveness of this habitat-based approach to fish and wildlife planning. Please send suggestions to:

Habitat Evaluation Procedures Group
Western Energy and Land Use Team
U.S. Fish and Wildlife Service
2627 Redwing Road
Ft. Collins, CO 80526

CONTENTS

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BLACK-CAPPED CHICKADEE (*Parus atricapillus*)

HABITAT USE INFORMATION

General

The black-capped chickadee (*Parus atricapillus*) inhabits wooded areas in the northern United States, Canada, and the higher elevations of mountains in southern Appalachia (Tanner 1952; Brewer 1963; Merritt 1981). The black-capped chickadee nests in cavities in dead or hollow trees (Nickell 1956), in a variety of forest types (Dixon 1961).

Food

Black-capped chickadees are insectivorous gleaners (Brewer 1963; Sturman 1968b) that select prey in proportion to its availability (Brewer 1963). Insect food is mostly gleaned from tree bark on twigs, branches, and boles; or from the foliage, fruits, and flowers of trees (Brewer 1963). Caterpillars are an important food for nestling chickadees (Odum 1942; Kluyver 1961; Sturman 1968a). Insect and spider eggs make up a large portion of the winter diet, and, although the use of plant material for food is low during much of the year, seeds of trees and shrubs may account for about half of the winter diet (Martin et al. 1961). Seeds of weedy plants, such as giant ragweed (*Ambrosia* spp.), are favorite winter foods (Fitch 1958).

Black-capped chickadees are versatile in their foraging habits and forage from the ground to the tree tops in a variety of habitats, although they prefer to forage at low or intermediate heights in trees and shrubs (Odum 1942). Chickadees in British Columbia showed a preference for foraging within 1.5 m (5.0 ft) of the ground (Smith 1967).

Black-capped chickadees in western Washington selected their territories before the amount of insect food (especially caterpillars) was apparent, and it appeared that canopy volume of trees was the proximate cue used by the chickadees to determine potential food supply, since chickadee abundance showed a strong positive correlation with canopy volume (Sturman 1968a). Caterpillars eat foliage and their abundance should vary directly with total foliage weight. There was a strong positive correlation between total foliage weight and canopy volume, and, hence, canopy volume provided a good estimate of potential insect abundance. The highest chickadee densities occurred at canopy volumes of about 10.2 m^3 of foliage/1 m^2 of ground surface (33.5 ft^3/ft^2).

Water

Drinking water requirements are met with surface water and snow (Odum 1942).

Cover

The black-capped chickadee occurs in both deciduous and evergreen forests in the eastern United States, although it is restricted to deciduous forests along streams in the Northern Great Plains, northern Rocky Mountains, and Great Basin areas (Dixon 1961). In some areas where the ranges of the black-capped chickadee and Carolina chickadee (P. carolinensis) come together, apparently suitable habitat exists where neither chickadee occurs (Tanner 1952; Brewer 1963; Merritt 1981). Deciduous forest types are preferred in western Washington (Sturman 1968a) and commonly used in Oregon (Gabrielson and Jewett 1940). Fall and winter roosts in New York were mostly on dense conifer branches, with some use of cavities (Odum 1942). Black-capped chickadees in Oregon and Washington excavated winter roost cavities in snags (Thomas et al. 1979). Winter roosts in deciduous forests of Minnesota were on the branches of trees and bushes that had retained their foliage (Van Gorp and Langager 1974).

Black-capped chickadee populations in Kansas tended to concentrate along edges between forest and early successional areas (Fitch 1958). The availability of suitable tree cavities for roosting may have been a limiting factor in this study area.

Reproduction

The black-capped chickadee nests in a cavity, usually in a dead or hollow tree (Nickell 1956). The presence of available nest sites, or trees that could be excavated, appeared to determine the chickadee's choice of nesting habitat. Two important factors affecting the use of stub trees in Michigan were height and the suitability of the tree for excavation (Brewer 1963). Willows (Salix spp.), pines (Pinus spp.), cottonwoods and poplars (Populus spp.), and fruit trees of the genera Pyrus and Prunus are frequently chosen for nest sites (Brewer 1961).

Black-capped chickadees are only able to excavate a cavity in soft or rotten wood (Odum 1941a, b). Trees with decayed heartwood, but firm sapwood, are usually chosen (Brewer 1961). Black-capped chickadees almost always do some excavation at the nest site (Tyler 1946), although they will use existing woodpecker holes, natural cavities, man-made nest boxes, and open topped fence posts (Nickell 1956). The average tree diameter at nest sites was 11.4 cm (4.5 inches), and preferred tree stubs apparently ranged from 10 to 15 cm (3.9 to 5.9 inches) in diameter (Brewer 1963). The minimum dbh of cavity trees used by black-capped chickadees is 10.2 cm (4 inches) (Thomas et al. 1979). Heights of 18 nests in New York ranged from 0.3 to 12.2 m (1 to 40 ft), although only three nests were higher than 4.6 m (15 ft) and 11 nests were under 3.0 m (10 ft) (Odum 1941b).

Nests in New York were usually located in open areas, commonly in young forests, hedgerows, or field borders (Odum 1941a). Willow, alder (Alnus spp.) and cottonwood trees were common nest trees in Washington (Jewett et al. 1953). Black-capped chickadees used second growth alder for nesting sites in British Columbia (Smith 1967).

Interspersion

Black-capped chickadees maintain a territory during the breeding season and flock in the winter months (Odum 1941b; Stefanski 1967). Territory size during nest building in Utah averaged 2.3 ha (5.8 acres) (Stefanski 1967).

Territory size in New York varied from 3.4 ha to 6.9 ha (8.4 to 17.1 acres), with an average size of 5.3 ha (13.2 acres) (Odum 1941a). The larger terri-tories were in open or sparsely wooded country; the size of the territory decreased as the nesting period progressed. The mean home range size of winter flocks was 9.9 ha (24.4 acres) in Kansas (Fitch 1958), 15.0 ha (37 acres) in Michigan (Brewer 1978), and 14.6 ha (36 acres) in New York (Odum 1942) and in Minnesota (Ritchison 1979).

Black-capped chickadees nesting on forest islands in central New Jersey did not nest in forests less than 2 ha (4.8 acres) in size (Galli et al. 1976). However, this apparent dependency on a minimum size forest may have been due to a lack of nesting cavities.

HABITAT SUITABILITY INDEX (HSI) MODEL

Model Applicability

Geographic area. This model was developed for the entire breeding range of the-black-capped chickadee.

Season. This model was developed to evaluate the breeding season habitat needs of the black-capped chickadee.

Cover types. This model was developed to evaluate habitat in Deciduous Forest (DF), Evergreen Forest (EF), Deciduous Forested Wetland (DFW), and Evergreen Forested Wetland (EFW) areas (terminology follows that of U.S. Fish and Wildlife Service 1981). It should be noted that, although the chickadee occurs in both deciduous and evergreen forests over much of its range, apparently there are geographic differences in use of cover types that limit the use of evergreen forests in parts of its range. Users should be familiar with the chickadee's major cover type preferences in their particular area before applying this model.

Minimum habitat area. Minimum habitat area is defined as the minimum amount of contiguous habitat that is required before an area will be occupied by a species. Although Galli et al. (1976) report that black-capped chickadees may be dependent on certain forest sizes, other studies state that these chickadees will nest in hedgerows and field borders. This model assumes that forest size is not an important factor in assessing habitat suitability for the black-capped chickadees.

Verification level. Previous drafts of this model were reviewed by Peter Merritt, and his specific comments have been incorporated into the current draft (Merritt, pers. comm.).

Model Description

Overview. This model considers the ability of the habitat to meet the food and reproductive needs of the black-capped chickadee as an indication of overall habitat suitability. Cover needs are assumed to be met by food and reproductive requirements and water is assumed not to be limiting. The food component of this model assesses vegetation conditions, and the reproduction component assesses the abundance of suitable snags. The relationship between habitat variables, life requisites, cover types, and the HSI for the black-capped chickadee is illustrated in Figure 1.

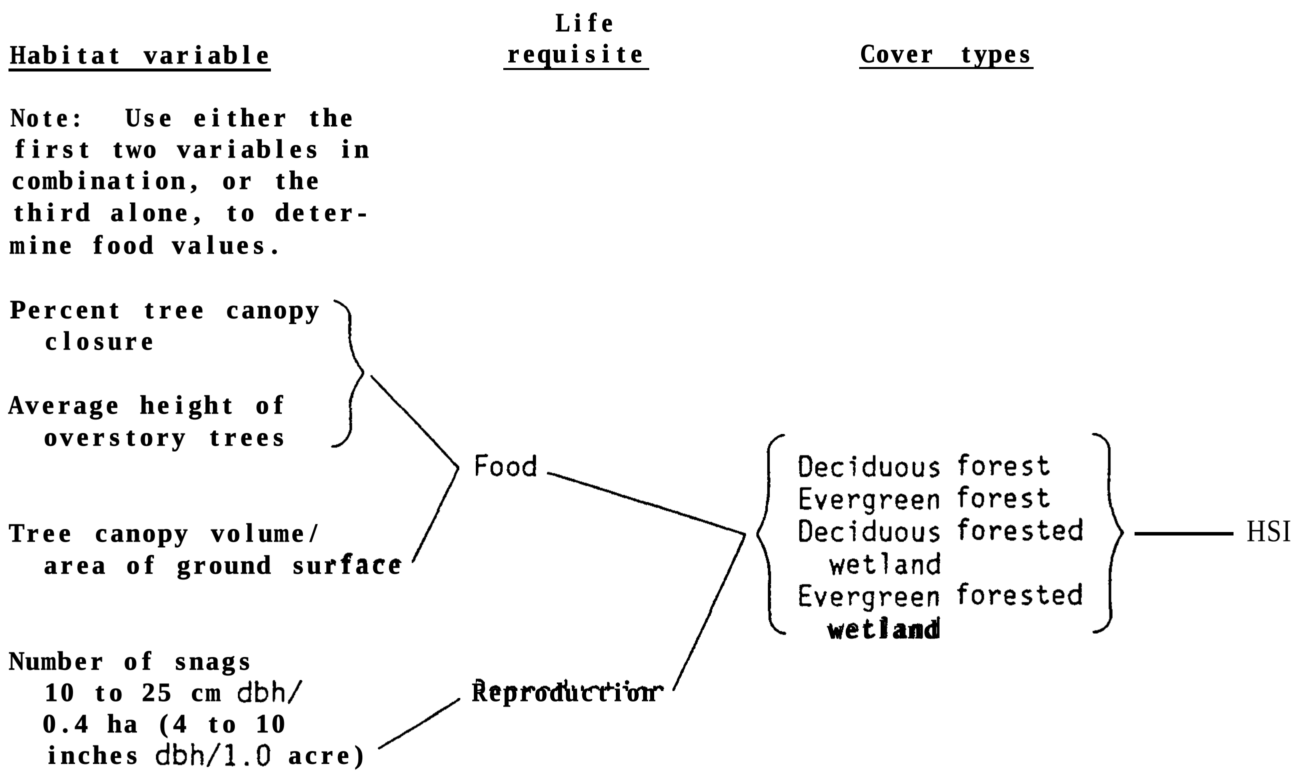


Figure 1. Relationship of habitat variables, life requisites, and cover types in the black-capped chickadee model.

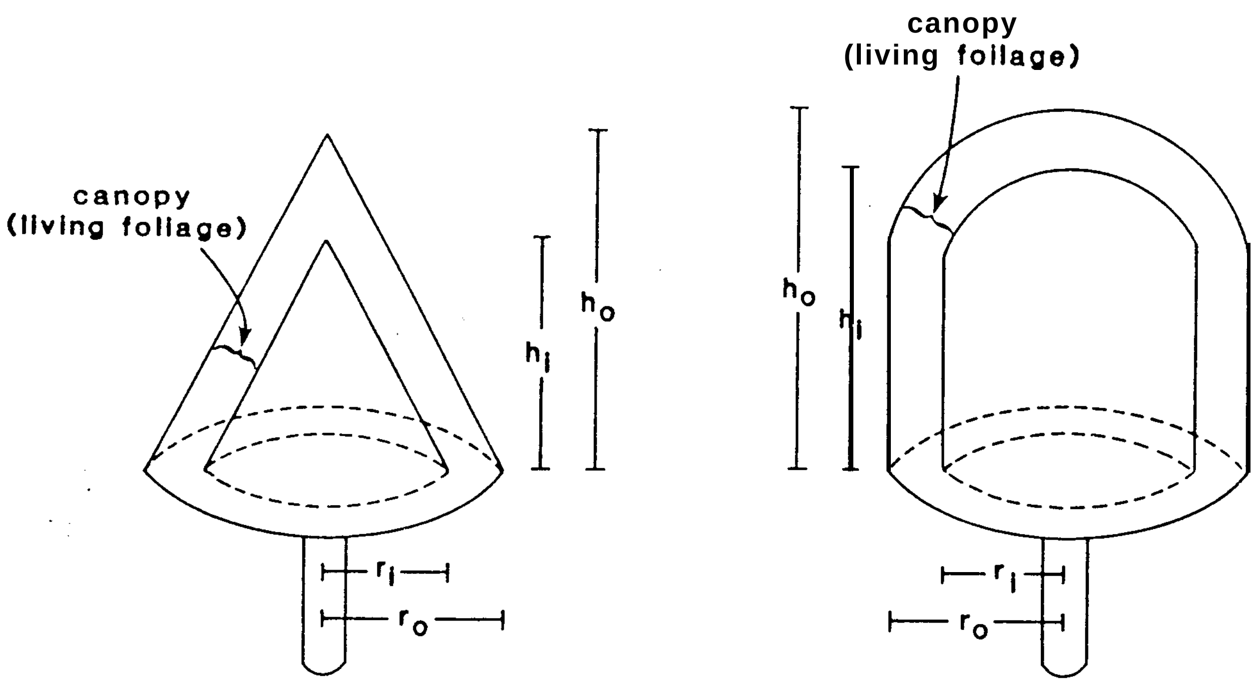
The following sections provide a written documentation of the logic and assumptions used to interpret the habitat information for the black-capped chickadee in order to explain the variables and equations that are used in the HSI model. Specifically, these sections cover the following: (1) identification of variables that will be used in the model; (2) definition and justification of the suitability levels of each variable; and (3) description of the assumed relationship between variables.

Food component. The majority of the year-round food supply of the black-capped chickadee is associated with trees. It is assumed that an accurate assessment of food suitability for the chickadee can be provided by a measure of either: (1) tree canopy closure and the average height of overstory trees; or (2) canopy volume of trees per area of ground surface. It is assumed that optimum canopy closures occur betwen 50 and 75%. A completely closed canopy will have less than optimum value due to an assumed lack of foliage in the middle and lower canopy layers. It is assumed that optimum habitats contain overstory trees 15 m (49.2 ft) or more in height. Habitats with a low canopy closure can provide moderate suitability for black-capped chickadees if tree heights are optimum. Likewise, habitats with short trees may have moderate suitability if canopy closures are optimum.

The canopy volume of an individual tree is equal to the area occupied by the living foliage of that tree, as shown in Figure 2 for deciduous and coniferous trees. Optimum canopy volume per area of ground surface exceeds 10.2 m^3 of foliage/m^2 of ground surface (33.5 ft^3 of foliage/ft^2 of ground surface). Suitability will decrease to zero as canopy volume approaches zero.

The field user should measure either: (1) tree canopy closure and tree height; or (2) tree canopy volume per area of ground surface. Tree canopy closure and tree height measurements are probably the most rapid method to assess food suitability. However, the suitability levels of these variables were not based on strong data sources. The suitability levels of tree canopy volume were based on data from Sturman (1968a).

Reproduction component. Black-capped chickadees nest primarily in small dead or hollow trees and can only excavate a cavity in soft or rotten wood. Therefore, reproduction suitability is assumed to be related to the abundance of small snags. It is assumed that snags between 10 and 25 cm (4 and 10 inches) dbh are required. Thomas et al. (1979) and Evans and Conner (1979) provide methods to estimate the number of snags required for cavity nesting birds. Assuming a territory size of 2.4 ha (6.0 acres) and a need for one cavity per year per chickadee pair, the method of Thomas et al. (1979) estimates that optimum habitats provide 5.9 snags/ha (2.4/acre), and the method of Evans and Conner (1979) estimates that 4.1 snags are needed per ha (1.67/acre) to provide optimum conditions. This model assumes that optimum suitability exists when there are five or more snags of the proper size per ha (2/acre), and that suitability will decrease to zero as the number of snags approaches zero.



CONIFEROUS

$$CV = \pi/3(h_o r_o^2 - h_i r_i^2)$$

DECIDUOUS

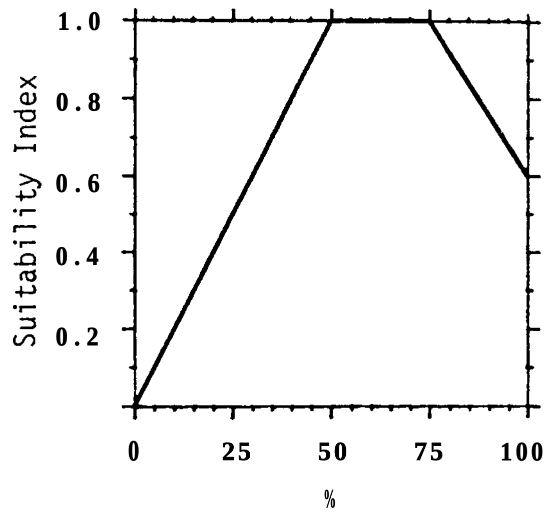
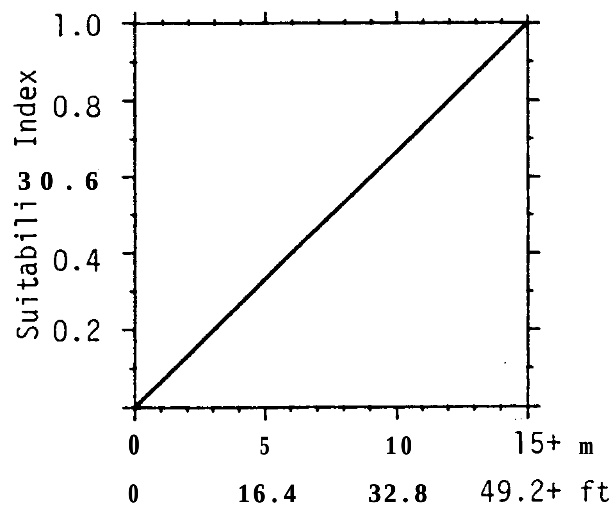
$$CV = 2\,\pi/3(h_o r_o^2 - h_i r_i^2)$$

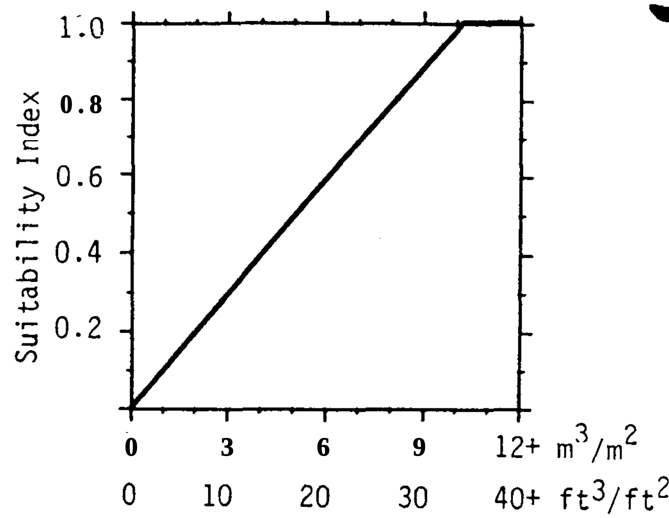
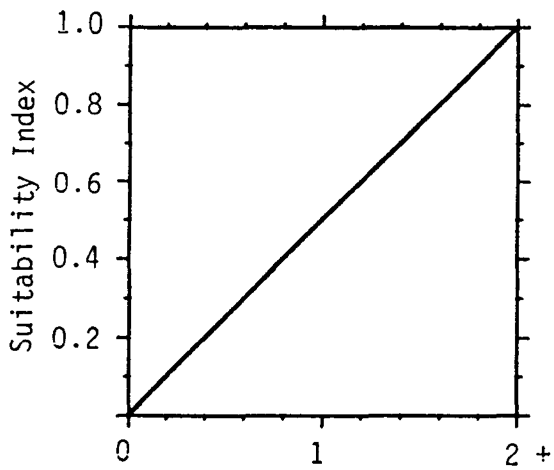
where: h_i = inner height
h_o = outer height
r_i = inner radius
r_o = outer radius

Figure 2. Tree shapes assumed and formulae used to calculate canopy volume (CV). (From Sturman 1968a).

Model Relationships

Suitability Index (SI) graphs for habitat variables. This section contains SI graphs that illustrate the habitat relationships described in the previous section.

Cover type	Variable		Suitability graph
DF,EF, DFW,EFW	V_1	Percent tree canopy closure.	
DF,EF, DFW,EFW	V_2	Average height of overstory trees.	

DF, EF, DFW, EFW	V_3	Tree canopy volume/area of ground surface.	
DF, EF, DFW, EFW	V_4	Number of snags 10 to 25 cm dbh/0.4 ha (4 to 10 inches dbh/1.0 acre).	

<u>Equations</u>. In order to determine life requisite values for the black-capped chickadee, the SI values for appropriate variables must be combined through the use of equations. A discussion and explanation of the assumed relationships between variables was included under <u>Model Description</u>, and the specific equations in this model were chosen to mimic these perceived biological relationships as closely as possible. The suggested equations for obtaining food and reproduction values are presented below.

Life requisite	Cover type	Equation
Food	DF,EF,DFW,EFW	$(V_1 \times V_2)^{1/2}$ or V_3 (See page 5 for discussion on which to use)
Reproduction	DF,EF,DFW,EFW	V_4

HSI determination. The HSI for the black-capped chickadee is equal to the lowest life requisite value.

Application of the Model

Definitions of variables and suggested field measurement techniques (from Hays et al. 1981, unless otherwise noted) are provided in Figure 3.

Variable (definition)		Cover types	Suggested technique
V_1	Percent tree canopy closure [the percent of the ground surface that is shaded by a vertical projection of the canopies of all woody vegetation taller than 5.0 m (16.5 ft)].	DF,EF,DFW,EFW	Line intercept
V_2	Average height of overstory trees (the average height from the ground surface to the top of those trees which are ≥ 80 percent of the height of the tallest tree in the stand).	DF,EF,DFW,EFW	Graduated rod, trigonometric hypsometry
V_3	Tree canopy volume/ area of ground surface (the sum of the volume of the canopies of each tree sampled divided by the total area sampled).	DF,EF,DFW,EFW	Quadrat and refer to Figure 2 on page 6

Figure 3. Definitions of variables and suggested measurement techniques.

Variable (definition)	Cover types	Suggested technique
V_4 Number of snags 10 to 25 cm dbh/0.4 ha (4 to 10 inches dbh/1.0 acre) [the number of standing dead trees or partly dead trees in the size class indicated that are at least 1.8 m (6 ft) tall. Trees in which at least 50% of the branches have fallen, or are present but no longer bear foliage, are to be considered snags].	DF,EF,DFW,EFW	Quadrat

Figure 3. (concluded).

SOURCES OF OTHER MODELS

Sturman (1968a) developed a multiple regression model for the black-capped chickadee in western Washington in which the canopy volume of trees accounted for 79.6% of the variation in chickadee abundance. Canopy volume of bushes and canopy volume of midstory trees were the next two most important variables, and their addition into the regression accounted for over half of the residual variation remaining after the canopy volume of trees was entered.

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Habitat Evaluation Procedures Group
Western Energy and Land Use Team
U.S. Fish and Wildlife Service
Drake Creekside Building One
2627 Redwing Road
Fort Collins, CO 80526

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16. Abstract (Limit: 200 words)

A review and synthesis of existing information was used to develop a habitat model for the black-capped chickadee (*Parus atricapillus*). The model is scaled to produce an index of habitat suitability between 0 (unsuitable habitat) and 1 (optimally suitable habitat) for areas of the continental United States. Habitat suitability indexes are designed for use with Habitat Evaluation Procedures previously developed by the U.S. Fish and Wildlife Service.

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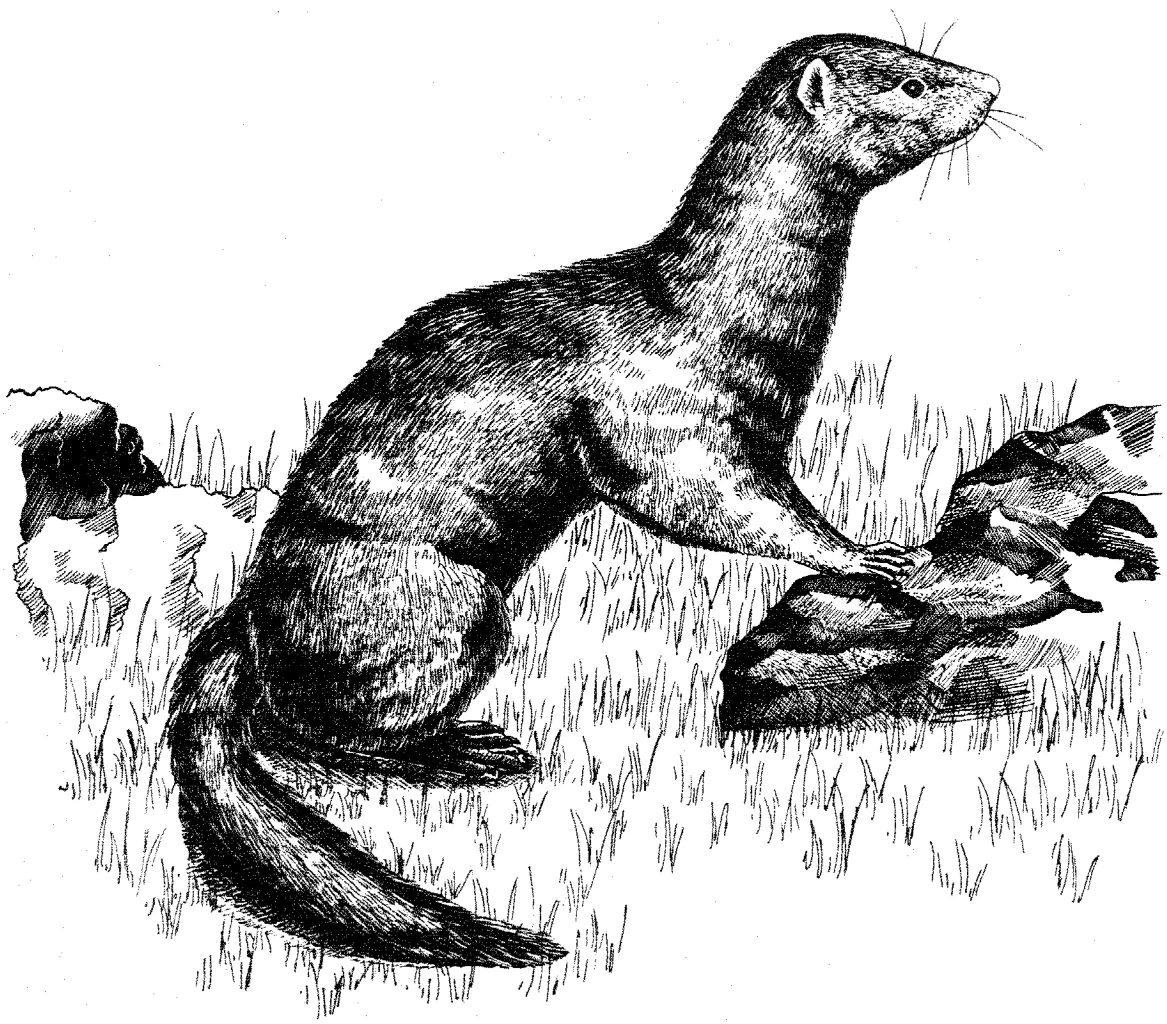
HABITAT SUITABILITY INDEX MODELS: MINK



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by

Arthur W. Allen
Habitat Evaluation Procedures Group
Western Energy and Land Use Team
U.S. Fish and Wildlife Service
Drake Creekside Building One
2627 Redwing Road
Fort Collins, CO 80526-2899

Western Energy and Land Use Team
Division of Biological Services
Research and Development
Fish and Wildlife Service
U.S. Department of the Interior
Washington, DC 20240

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PREFACE

This document is part of the Habitat Suitability Index (HSI) Model Series (FWS/OBS-82/10), which provides habitat information useful for impact assessment and habitat management. Several types of habitat information are provided. The Habitat Use Information Section is largely constrained to those data that can be used to derive quantitative relationships between key environmental variables and habitat suitability. The habitat use information provides the foundation for HSI models that follow. In addition, this same information may be useful in the development of other models more appropriate to specific assessment or evaluation needs.

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2627 Redwing Road
Ft. Collins, CO 80526-2899

CONTENTS

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MINK (*Mustela vison*)

HABITAT USE INFORMATION

General

The mink (*Mustela vison*) is a predatory, semiaquatic mammal that is generally associated with stream and river banks, lake shores, fresh and saltwater marshes, and marine shore habitats (Gerell 1970). Mink are chiefly nocturnal and remain active throughout the year (Marshall 1936; Gerell 1969; Burgess 1978). The species is adaptable in its use of habitat, modifying daily habits according to environmental conditions, particularly prey availability (Wise et al. 1981; Linn and Birks 1981; Birks and Linn 1982). The species is tolerant of human activity and will inhabit suboptimum habitats as long as an adequate food source is available; however, mink will be more mobile and change home ranges more frequently under such conditions (Linn pers. comm.).

Food

The mink's foraging niche is typically associated with aquatic habitats (Gerell 1969; Eberhardt and Sargeant 1977; Chanin and Linn 1980; Wise et al. 1981). The species exhibits considerable variation in its diet, according to season, prey availability, and habitat type (Burgess 1978; Chanin and Linn 1980; Melquist et al. 1981; Wise et al. 1981; Linscombe et al. 1982). Predation by mink in North Dakota appeared to be directed toward the most vulnerable individuals among available prey species (Sargeant et al. 1973). Preferred mink prey can be broadly categorized into three groups: (1) aquatic [e.g., fish and crayfish (*Cambarus* spp.)]; (2) semiaquatic [e.g., waterfowl and water associated mammals, such as the muskrat (*Ondatra zibethicus*)]; and (3) terrestrial (e.g., rabbits and rodents) (Chanin pers. comm.). If prey in any one of these categories is available throughout the year, the habitat may be suitable for mink.

Fish occurred more frequently (59%) in the mink's diet in Idaho than did any other prey category (Melquist et al. 1981). Unidentified cyprinids, ranging in length from 7 to 12 cm (2.7 to 4.7 inches) were the major group of prey fish. Larger fish, represented by salmonids, accounted for 9% of the diet. These larger fish were believed too large for mink to prey on and were probably scavenged. Fish, shellfish, and crustaceans were the major food items of mink inhabiting coastal habitats of Alaska and British Columbia (Harbo 1958 cited by Pendleton 1982, Hatler 1976).

Eberhardt and Sargeant (1977) reported that birds, mammals, amphibians, and reptiles accounted for 78%, 19%, 2%, and 1%, respectively, of the vertebrate prey consumed by mink in North Dakota prairie marshes. Waterfowl accounted for 86% of the avian prey, with coots (Fulica americana), ducks (Anseriformes), and grebes (Podicipediformes) comprising 70%, 11%, and 5%, respectively, of the total. The relative amount of each prey species eaten closely paralleled the relative abundance of the species. The high use of avian prey in North Dakota prairie marshes was believed to be a result of high waterfowl densities and the scarcity of other prey species, particularly fish and crayfish. Talent et al. (1983) concluded that predation by mink was the principle cause of duckling mortality in their North Dakota study. Waterfowl were also an important component of the diet of mink in Idaho during spring and early summer when young ducks were abundant (Melquist et al. 1981). Fish, crayfish, rodents, and birds are the principle prey of mink in Sweden (Gerell 1969). Fish are preferentially consumed in winter and spring due to their increased vulnerability, resulting from low water levels and low temperatures. Crayfish occurred most frequently in the mink's diet during the summer months in Sweden (Gerell 1967). Crayfish were also the most important component of the mink's summer diet in Quebec (Burgess 1978). Crayfish are a prominent component of the mink's diet in Louisiana and, when abundant, support high mink populations (Lowery 1974; Linscombe and Kinler pers. comm.). Mink populations in Louisiana are believed to cycle with, or slightly behind peaks in crayfish populations (Linscombe and Kinler pers. comm.).

With the approach of fall, small terrestrial mammals play an increasingly important role in the mink's diet (Gerell 1967, 1969; Burgess 1978). Small mammals associated with riparian habitats accounted for 43% of the mink's diet in Idaho (Melquist et al. 1981). Small mammals accounted for more than 20% of the fall/winter diet in North Carolina (Wilson 1954). Terrestrial prey species in Great Britain may be of equal importance in the mink's diet as are aquatic prey species (Birks pers. comm.). Rabbits may comprise up to 50% of the mink's diet even in areas where aquatic prey are abundant. Muskrats have been reported to be an important part of the mink's diet throughout its range (Hamilton 1940). Sealander (1943) reported that muskrats were a major component of the winter diet of mink in southern Michigan. However, Errington (1943) believed that muskrats became a significant food source for mink only during periods of muskrat overpopulation, epidemic diseases of muskrats, or drought. Muskrats were the most important component of the mink's diet in Ontario (McDonnell and Gilbert 1981). Predation on muskrats increased during the fall months as marsh water level decreased. Melquist et al. (1981) believed that only adult male mink were large enough to consistently prey upon muskrats.

Water

The majority of mink activity in Quebec was within 3 m (9.8 ft) of the edges of streams (Burgess 1978). All of the mink observations in a Michigan study were within 30.4 m (100 ft) of the water's edge (Marshall 1936). The majority of mink den sites recorded in a British study were within 10 m (32.8 ft) of the water's edge (Birks and Linn 1982). Mink den sites in Minnesota were within 69.9 m (200 ft) of open water (Schladweiler and Storm 1969). Den sites in Idaho were 5 to 100 m (16.4 to 328 ft) from water, and mink were never observed further than 200 m (656 ft) from water (Melquist et al. 1981). Mink activity in Quebec dropped sharply as stream flow increased (Burgess 1978). Korschgen (1958) reported that the use of aquatic foods by mink in Missouri increased as water levels decreased.

Cover

Mink in Michigan and Sweden are most commonly associated with brushy or wooded cover adjacent to aquatic habitats (Marshall 1936; Gerell 1970). Mink in a Quebec study were normally most active in wooded areas immediately adjacent to a stream channel (Burgess 1978). During the latter part of the summer, when terrestrial foods became a more significant component of the mink's diet, this relationship became less well defined. In England, mink movements of up to approximately 200 m (656 ft) from water are not uncommon, particularly when aquatic prey is scarce (Linn and Birks 1981). When upland habitats are used by mink, ecotones receive most use due to increased cover and small mammal availability. Mink generally avoid exposed or open areas (Gerell 1970; Burgess 1978). Shrubby vegetation furnishing a dense tangle provide suitable cover for mink (Linn pers. comm.). Grasses, even if very tall, do not provide adequate year-round cover for the species. However, harvest data in Louisiana suggests that marshes containing dense stands of sawgrass (Cladium jamaicense) support high densities of mink (Linscombe and Kinler pers. comm.). Thick stands of sawgrass are believed to provide excellent cover, elevation above the water level, and prey for mink. However, significantly more mink are captured in southern Louisiana swamps than marshes (Nichols and Chabreck 1981). The greater abundance of mink in cypress-tupelo (Taxodium distichum - Nyssa aquatica) swamps is partially attributed to a greater abundance of food resources and potential den sites than are present in marsh habitats. These findings are consistent with the belief that cypress-tupelo swamps are Louisiana's best mink producing areas (St. Amant 1959, cited by Nichols and Chabreck 1981). Gerell (1970) characterized mink habitat in Sweden as small, oligotrophic lakes with stony shores and streams surrounded by marsh vegetation. The shores of wetland habitats with dense vegetation are the most suitable mink habitat in Michigan (Marshall 1936) and England (Linn and Stevenson 1980). Virtually all mink locations recorded in a North Dakota study were within 20 m (66 ft) of emergent vegetation (Eagle pers. comm.). Evaluating duckling mortality in North Dakota, Talent et al. (1983) found that predation by mink typically occurred on semipermanent wetlands. Based on a lower rate of predation and less mink sign associated with seasonal wetlands, it was believed that semipermanent wetlands provided more suitable mink habitat than did less permanent wetland types. Wetlands with irregular and diverse shorelines provide more suitable mink habitat than do wetlands with straight, open, exposed shorelines (Croxton 1960; Waller 1962). Rapid declines in mink activity along Ontario lake shores were recorded where relatively small increases in human development had taken place (Racey and Euler 1983). The construction of cottages adjacent to lake shorelines typically resulted in reduced vegetative cover and diminished shoreline complexity due to the removal of snags, stones, aquatic vegetation, and the development of sand beaches. The decreased complexity of shoreline habitats was believed to reduce the amount of shelter available to crayfish resulting in decreased mink prey availability. Habitats associated with small streams are preferred to those associated with large, broad rivers (Davis 1960). Mink are most common along streams where there is an abundance of downfall or debris for cover and pools for foraging. Log jams provide excellent foraging cover for mink because they provide shelter for aquatic organisms and security for mink (Melquist et al. 1981). Burgess (1978) recorded a 52.5% increase in mink activity along a stream reach in Quebec that had undergone habitat improvement. Stream alterations consisted of the creation of pools up to 1 m (3.38 ft) deep in 50% of the stream channel and the placement of logs and other cover within the channel. Dunstone and O'Connor (1979) attributed the mink's use of stream and lake edges to the inability of mink to efficiently forage in open water. Cover associated with aquatic ecotones allowed a stealthier approach and development of specific search strategies by mink (Dunstone 1978). Open water was believed to provide potentially suitable foraging areas only during periods of reduced water volume or high fish density.

The availability of suitable dens may limit the ability of a habitat to support mink (Errington 1961; Gerell 1970; Northcott et al. 1974; Birks and Linn 1982). The absence of dry den sites may limit the mink's use of some wetlands (Linn pers. comm.). Mink typically select den sites that are close to preferred foraging areas or concentrations of prey items (Linn and Birks 1981; Melquist et al. 1981; Birks and Linn 1982). Mink use several dens within their home range for concealment, shelter, and litter rearing (Marshall 1936; Schladweiler and Storm 1969; Gerell 1970; Eberhardt 1973; Eberhardt and Sargeant 1977; Linn and Birks 1981; Melquist et al. 1981; Birks and Linn 1982). Maximum consecutive days of occupation of single dens in North Dakota was approximately 40 days (Eberhardt and Sargeant 1977). After kits became more mature, individual dens were used briefly and irregularly. The majority of den stays in England were less than 1 day in duration (Birks and Linn 1982). The mean distance covered for 12 den moves in North Dakota was 234 m (767.5 ft) (Eberhardt and Sargeant 1977). The mean distance between dens used for two or more consecutive days in Sweden was 544 m (1784.3 ft) (Gerell 1970). The mean inter-den distance recorded in England was 492.2 m (1614.9 ft) (Birks and Linn 1982). Movements of male mink to new den sites tended to be greater than those recorded for females of the species. New mink dens in Wisconsin were usually within 90 m (295 ft) of the previous den site (Schladweiler and Storm 1969). The majority of inter-den movements are made at night and typically occur in, or along, linear habitat features such as lake shores, river banks, stream courses, or hedge-rows (Birks and Linn 1982). Gerell (1970) reported that the most "commonly" used dens were located in cavities beneath tree roots at the water's edge. However, "more preferred", but less common, den sites were within cavities or piles of rocks well above the water line. Birks and Linn (1982) also identified cavities within, or beneath, waterside trees as being an important source of den sites for mink. Mink dens adjacent to lake shorelines in Ontario were located in sites with higher than average numbers of deadfalls and stumps and greater shrub and tree stem densities (Racey and Euler 1983). Log jams accounted for 53% of the mink dens located in Idaho (Melquist et al. 1981). Fallen branches, brush, and other debris provided additional den sites. The use of log jams increased during December, probably as a result of decreased accessibility to other den sites due to increasing snow depth. All mink dens located in North Dakota were situated on marsh shorelines and appeared to be in abandoned or seldom used muskrat burrows (Eberhardt 1973; Sargeant et al. 1973; Eberhardt and Sargeant 1977). The availability of dens for mink use was believed to be related to the suitability of the wetland for muskrats and the amount of shoreline grazing by livestock. Active mink dens were not located on heavily grazed shorelines. Errington (1954) characterized prime mink habitat in the northcentral region of the United States as being choice muskrat habitat. Extremely high mink harvests have occurred in association with high muskrat populations in Louisiana (Linscombe and Kinler pers. comm.). The highest densities of muskrats in Louisiana occur in association with bulrush (Scirpus olneyi).

Reproduction

No information relating specifically to habitat needs for reproduction was found in the available literature.

Interspersion

The home ranges of mink tend to approximate the shape of the water body along which they live (Gerell 1970; Linn and Birks 1981). A mink's use of its home range varies in intensity due to varying prey availability. During daily activity periods, mink move back and forth in a restricted "core area" which typically does not exceed 300 m (984 ft) in shoreline length (Gerell 1970). Eventually, the mink will use another den within the home range as a base and will intensively forage within an associated core area. Linn and Birks (1981) found that the mink's home range in England typically contained one or two core areas that were associated with prey concentrations. Although core areas generally occupied a small proportion (mean = 9.3%) of the home range area, mink spent approximately 50% of their time within these areas (Birks and Linn 1982). When prey was abundant throughout the home range, the core areas were not as well defined. When the aquatic aspect of the habitat was nonlinear (e.g., marshes), the home range was smaller and less linear in shape. The mink's use of its home range also shows temporal variation in response to seasonal differences in prey availability (Birks and Linn 1982). Movements recorded in England indicated a general reduction in activity in winter relative to summer. Fewer den sites were used, occupancy at individual dens were of longer duration, and daily travel distances were shorter. Mink home range size in British Columbia was believed to be inversely related to the quality of forage areas (Hatler 1976). The overall mink population was believed to be limited by the number of high quality, year-long foraging areas. Harbo (1958 cited by Pendleton 1982) attributed higher mink populations and smaller activity areas along coastal Alaska to a relatively consistent year-long food supply in the intertidal zone.

Vegetative cover had a significant impact on mink home range size in Montana (Mitchell 1961). The home range size for female mink within a heavily vegetated area was estimated to be 7.7 ha (19.3 acres), while the home range of a female within a sparsely vegetated, heavily grazed area was 20.1 ha (50.2 acres). Female mink home ranges in Michigan did not exceed 8 ha (20 acres) (Marshall 1936). Mink in Idaho were believed to be able to sustain themselves in a 1 to 2 km (0.6 to 1.2 miles) section of stream length (Melquist et al. 1981). Mink population densities along the coast of Vancouver Island ranged from 1.5 to more than 3 animals/km (1.5 to 3/0.6 mi) of shoreline (Hatler 1976). Mink home range size in the prairie pothole region of North Dakota ranged from 2.59 km^2 to 3.8 km^2 (1 to 1.5 mi^2) and typically included numerous wetlands (Eagle pers. comm.). Female mink have the smallest and most well defined home range, while those of males tend to be more extensive and less well defined (Marshall 1936). The home range size for female mink in England was, on an average, 85.4% of a male's home range size (Birks and Linn 1982). Intrasexual and intersexual home range overlap was rare in a North Dakota study except during the 2 to 3 week breeding season in April (Eagle pers. comm.). Female mink in Sweden were found to be more restricted to riparian habitats while males transiently exploited upland areas (Gerell 1970). Male mink in England tended to forage away from aquatic habitats while females typically remained in close proximity to water (Birks and Linn 1982). Mink concentrating on aquatic prey tended to utilize larger core areas than individuals exploiting terrestrial prey species. Solely terrestrial foraging was exclusively a male activity and typically occurred where aquatic prey and prey associated with riparian habitats were scarce.

HABITAT SUITABILITY INDEX (HSI) MODEL

Model Applicability

Geographic area. This HSI model has been developed for application within inland wetland habitats throughout the range of the species.

Season. This HSI model was developed to evaluate the potential quality of year-round habitat for the mink.

Cover types. This model was developed to evaluate habitat in the following cover types (terminology follows that of U.S. Fish and Wildlife Service 1981): Evergreen Forested Wetland (EFW); Deciduous Forested Wetland (DFW); Evergreen Scrub-shrub Wetland (ESW); Deciduous Scrub-shrub Wetland (DSW); Herbaceous Wetland (HW); Riverine (R); and Lacustrine (L).

Minimum habitat area. Minimum habitat area is defined as the minimum amount of contiguous habitat that is required before an area will be occupied by a species. Information on the minimum habitat area for the mink was not found in the literature. The size and shape of mink home ranges vary in response to topography, food availability, and sex. Although home ranges of female mink are smaller than those of males, home ranges of both sexes tend to parallel the configuration of a body of water or wetland basin. Based on this information, it is assumed that any wetland, or wetland associated habitat, large enough to be identified and evaluated as such, has the potential to support mink.

Verification level. This HSI model provides habitat information useful for impact assessment and habitat management. The model is a hypothesis of species-habitat relationships and does not reflect proven cause and effect relationships. Earlier drafts of this model have been reviewed by Dr. Johnny Birks, University of Durham, Durham, Great Britain; Dr. Paul Chanin, University of Exeter, Devon, Great Britain; Mr. Thomas Eagle, University of Minnesota, Minneapolis, MN; Mr. John Hunt, Maine Department of Inland Fisheries and Wildlife, Augusta, ME; Mr. Noel Kinler, Louisiana Department of Wildlife and Fisheries, New Iberia, LA; Mr. Ian Linn, University of Exeter, Hatherly Laboratories, Exeter, Great Britain; Mr. Greg Linscombe, Louisiana Department of Wildlife and Fisheries, New Iberia, LA; Mr. John Major, Maine Cooperative Wildlife Research Unit, University of Maine, Orono, ME; and Mr. Barry Saunders, Ministry of Environment, British Columbia, Canada. Improvements and modifications suggested by these individuals have been incorporated into this model.

Model Description

Overview. The year-round habitat requirements of mink can be satisfied within wetland, riverine, or lacustrine cover types if sufficient vegetation or cover is present to support an adequate prey base. Although not totally restricted to wetland or wetland-associated habitats, the mink is dependent on aquatic organisms as a food source for a large portion of the year. Transient use of upland habitats may occur, particularly during the fall and winter months, when terrestrial prey plays an increasingly important role in the mink's diet. The majority of mink activity (foraging, establishment of dens, and litter rearing) occurs in close proximity to open water. This model assumes that sufficient vegetative cover must be interspersed with, or adjacent to, relatively permanent surface water to provide the maximum potential as mink habitat. It is assumed, in this model, that quality food and cover for the mink can be described by the same set of habitat characteristics. The reproductive habitat requirements of the mink are assumed to be identical to its cover habitat requirements.

The following sections provide documentation of the logic and assumptions used to translate habitat information for the mink to the variables and equations used in the HSI model. Specifically, these sections cover: (1) identification of variables used in the model; (2) definition and justification of the suitability levels of each variable; and (3) description of the assumed relationships between variables.

Figure 1 illustrates the relationships of habitat variables, life requisites, and cover types for the mink.

Food component. Mink are not totally dependent on aquatic or wetland-associated prey species. However, these species form the largest portion of the annual diet. It is assumed that surface water must be present for a minimum of nine months of the year to provide optimum foraging habitat for mink. Habitats with less permanent surface water are assumed to be less suitable mink habitat. Wetland habitats consisting only of saturated soils, or lacking surface water, are assumed to be of no value as year-round mink habitat.

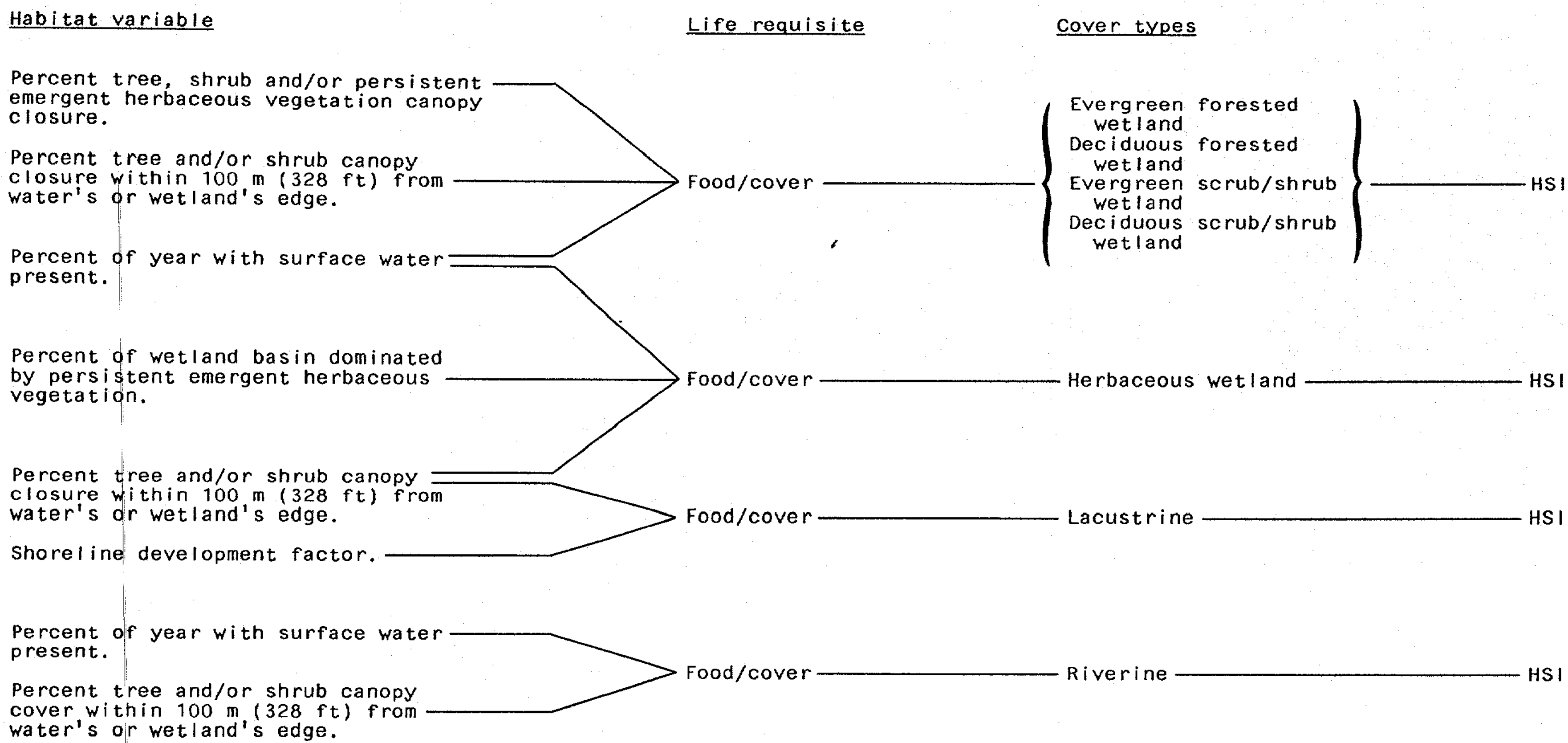


Figure 1. Relationships of habitat variables, life requisites, and cover types in the mink HSI model.

Several reviewers of this model have commented that eutrophic lakes have greater potential productivity than do oligotrophic lakes. Due to a more diverse and abundant aquatic prey base eutrophic lakes may be capable of supporting larger populations of mink. The primary productivity of a lake is dependent in part upon the nutrients received from the surrounding drainage, geological age, and water depth. Oligotrophic lakes are typically deep, with the hypolimnion larger than the epilimnion, littoral zone vegetation is scarce and organic content and plankton density are low. In contrast, eutrophic lakes are typically shallow, have high concentrations of plant nutrients (e.g., nitrogen, phosphorus), have high organic content, and littoral zone vegetation is generally abundant. Although this model does not take into account a specific evaluation of a lake's potential ability to produce food organisms, it should be realized that potential food production and a lake's ability to provide abundant aquatic prey for mink may vary based on the lake's physical and chemical structure.

Small terrestrial mammals become a more important component of the diet during the fall and winter months. Sufficient terrestrial vegetative cover interspersed with, or immediately adjacent to, water is assumed to provide an adequate source of prey species to supplement the aquatic portion of the mink's diet.

Cover component. Although mink will occasionally use upland habitats, they are most often found in close association with wetland cover types and the vegetative communities immediately adjacent to streams, rivers, and lakes. Dense woody cover provided by trees and/or shrubs provides the mink with potential den sites, escape cover, and foraging cover. Persistent herbaceous cover may also provide mink with sufficient cover for foraging and shelter. It is assumed that terrestrial herbaceous vegetation by itself will not provide sufficient cover for the mink during winter.

Suitable mink habitat within forested or scrub/shrub wetlands is assumed to be a function of the total canopy closure of shrubs, trees, and persistent emergent herbaceous vegetation within the wetland basin. Optimum conditions for cover, denning, and foraging are assumed to occur when the canopy closure of woody and persistent herbaceous vegetation exceeds 75%. Forested or scrub/shrub wetlands with lower vegetative canopy closures are assumed to be less suitable mink habitat. Woody vegetation within 100 m (328 ft) of a wetland's edge is assumed to also influence the potential quality of mink habitat. However, the degree to which vegetative quality in a 100 m (323 ft) band surrounding a forested or scrub/shrub wetland influences the potential habitat quality for mink is dependent on the wetland basins' size. In small forested or scrub/shrub wetlands the adjacent upland cover is assumed to play a relatively important role in defining overall habitat quality for the species. In contrast, the majority of mink inhabiting large, expansive forested or shrub wetlands probably do not utilize, nor are they influenced by the quality of adjacent upland habitats. In large forested or shrub wetlands potential habitat quality for mink is assumed to be a function only of the amount of woody and persistent herbaceous vegetation and the percent of the year with surface water present. Within small, or linear, forested, scrub/shrub wetland basins potential habitat quality is assumed to be a function of the canopy closure of woody and persistent herbaceous vegetation in the wetland basin, the percent of the year with surface water present, and the canopy closure of woody vegetation in a 100 m (328 ft) band adjacent to the wetland basin. For the purposes of this model, large wetland basins are assumed to be 405 ha (1,000 acres) or larger in size. However, this is an arbitrary figure used to separate small and large wetlands for application of the model. Users may wish to redefine this value based on experience with regional habitat classifications.

Suitable cover for mink in herbaceous wetlands is assumed to be a function of the amount of the wetland basin supporting persistent emergent herbaceous vegetation (e.g., cattails and rushes) and, to a lesser extent, the amount of woody cover immediately adjacent to the herbaceous wetland. Optimum cover conditions for mink in herbaceous wetlands are assumed to occur when the wetland basin consists of 50 to 75% persistent emergent herbaceous vegetation. Herbaceous wetlands with greater than 75% canopy cover of persistent emergent vegetation are assumed to provide lower prey diversity and have slightly less potential in meeting the year-round food requirements of mink. Less than 50% persistent emergent vegetation is assumed to be indicative of less suitable mink habitat. Wetlands totally devoid of persistent emergent vegetation are assumed to have minimum value as year-round mink habitat. The cover value for mink in herbaceous wetlands may be improved if woody vegetation is present within 100 m (328 ft) of the wetland's edge. However, the presence of persistent emergent vegetation is assumed to be the major characteristic defining potential mink habitat in herbaceous wetlands and has been weighted to reflect this assumption. As in the case of forested and shrub wetlands, the presence of surface water within herbaceous wetlands has a direct influence on the habitat potential for mink. Wetlands with surface water present for three months or less are assumed to be unsuitable habitat, while wetlands with surface water present nine months, or longer, are assumed to be indicative of optimum conditions.

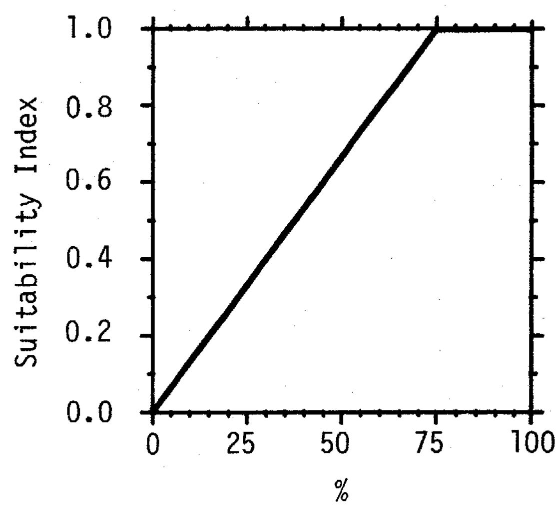
The quality of cover for mink in lacustrine habitats is assumed to be a function of the percent tree and/or shrub canopy closure within 100 m (328 ft) of the water's edge and the shape of the lake basin. A canopy closure of 75% or more of woody vegetation is assumed to characterize optimum vegetative cover. Cover quality is assumed to decrease as the density of woody vegetation decreases. However, because mink will utilize burrows, rock crevices and other forms of temporary shelter, the complete absence of woody vegetation is assumed to not totally limit an area's potential as mink habitat. Greater shoreline development (e.g., complexity) is assumed to reflect more suitable habitat conditions for the mink and its major aquatic prey species. Lakes with irregular and diverse shorelines are assumed to provide higher quality mink habitat than lakes with straight shores or lakes that are roughly circular in shape. The presence of peninsulas, islands, or inlets increases the shoreline edge and is assumed to provide more suitable access and foraging sites for the mink.

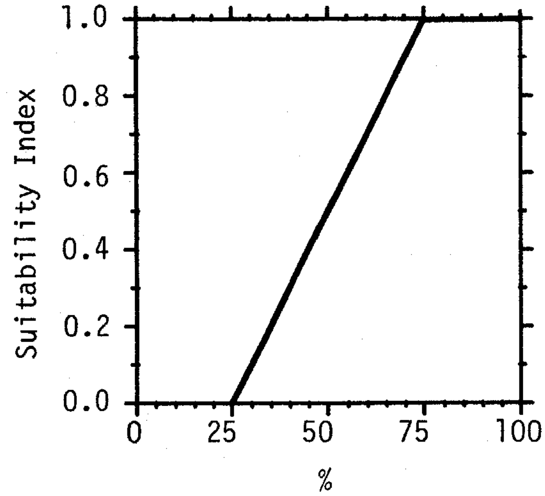
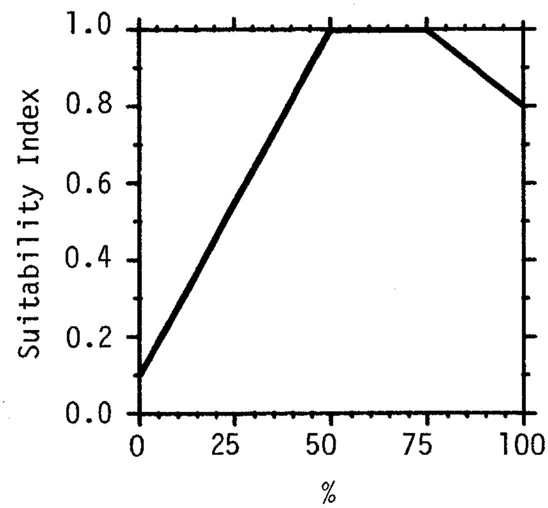
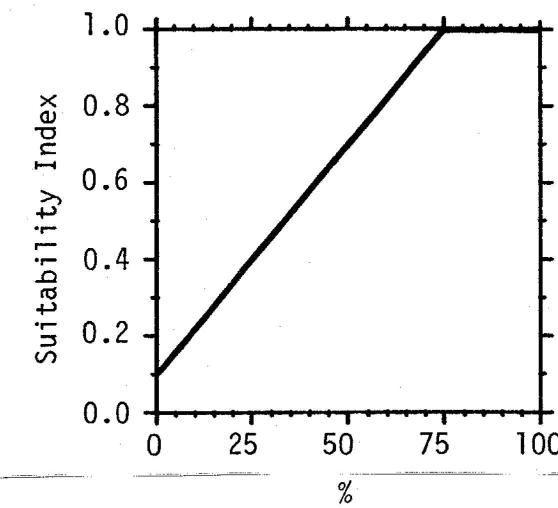
Within riverine cover types, suitable cover for mink is assumed to be related to the density of woody vegetation (trees and/or shrubs) within 100 m (328 ft) of the water's edge. Optimum conditions are assumed to exist when the canopy closure equals or exceeds 75%. Lower cover quality is characterized by less dense stands of woody vegetation adjacent to the river or stream channel. While optimum cover conditions are assumed to occur in riverine habitats bordered by trees and/or shrubs, the complete absence of woody vegetation is assumed to not totally limit the cover value. Minimum cover potential is assumed to exist in habitats devoid of woody vegetation based on the mink's use of other forms of shelter (e.g., rock crevices, animal burrows).

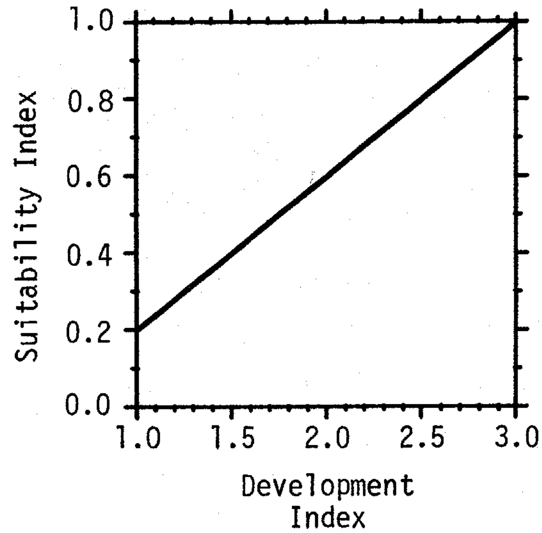
The vegetative cover values in all cover types used by mink are modified by the relative permanence of surface water, as discussed in the Food component section of this model. Even though the vegetative characteristics of a cover type may be of optimum value, it is assumed that mink habitat will not be present if surface water is not available. To provide optimum mink habitat, surface water must be present for a minimum of 9 months of the year.

Model Relationships

Suitability Index (SI) graphs for habitat variables. The relationships between various conditions of habitat variables and habitat suitability for the mink are graphically represented in this section.

Cover type	Variable		
EFW,DFW, ESW,DSW	V_1	Percent tree, shrub, and/or persistent emergent herbaceous vegetation canopy closure.	

EFW,DFW, ESW,DSW, HW,R,L	V_2	Percent of year with surface water present.	
HW	V_3	Percent of wetland basin dominated by persistent emergent herbaceous vegetation.	
EFW,DFW, DSW,ESW, HW,R,L	V_4	Percent tree and/or shrub canopy closure within 100 m (328 ft) of water's or wetland's edge.	

L	V_5	Shoreline development factor.	

Equations. In order to obtain life requisite values for the mink, the SI values for appropriate variables must be combined through the use of equations. A discussion and explanation of the assumed relationships between variables was included under Model Description, and the specific equations in this model were chosen to mimic these perceived biological relationships as closely as possible. The suggested equations for obtaining a food/cover value are presented by cover type in Figure 2.

Life requisite	Cover type	Equations
Food/cover	EFW,DFW,ESW,DSW [< 405 ha (1,000 acres) in size]	$V_2 \frac{V_1 + V_4}{2}$
Food/cover	EFW,DFW,ESW,DSW [≥ 405 ha (1,000 acres) in size]	$(V_1 \times V_2)^{1/2}$
Food/cover	HW	$V_2 \frac{4V_3 + V_4}{5}$
Food/cover	L	$(V_4 \times V_5)^{1/2}$
Food/cover	R	$(V_2^2 \times V_4)^{1/3}$

Figure 2. Equations for determining life requisite values by cover type for the mink.

HSI determination. Because food/cover was the only life requisite considered in this model, the HSI equals the food/cover value determined for a specific cover type.

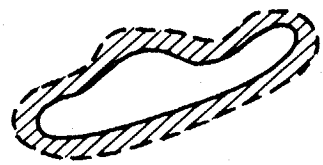
Application of the Model

Potential mink habitat must contain a relatively permanent source of surface water. Because of the mink's use of upland habitats for denning and foraging, optimum mink habitat must also contain suitable cover adjacent to the water body or wetland. Therefore, the application of this model and the determination of habitat units is based on an evaluation of the quality of the wetland, lacustrine, or riverine cover type and a 100 m (328 ft) band of habitat surrounding the aquatic portion of the habitat. Figure 3 illustrates the relationship of cover types to the suggested evaluation area.

Cover type — Area for evaluation

Lacustrine

HSI determined only for area contained within 100 m (328 ft) band around lake.



Riverine

HSI determined for area within 100 m band on both sides of river plus area of river.

Palustrine (herbaceous wetlands, forested wetlands, or shrub wetlands). Less than 405 ha (1,000 acres) in size.

HSI determined for area contained within cover type plus area within 100 m band around wetland cover type.

Palustrine (forested wetlands or shrub wetlands) 405 ha (1,000 acres) or larger in size HSI determined for area contained only within cover type.

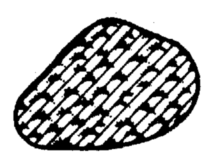


Figure 3. Guidelines for determining the area to be evaluated for mink habitat suitability under various cover type conditions.

Definitions of variables and suggested field measurement techniques (Hays et al. 1981) are provided in Figure 4.

Variable (definition)		Cover types	Suggested technique
V_1	Percent tree, shrub, and/or persistent emergent herbaceous canopy closure [the percent of the ground surface that is shaded by a vertical projection of the canopies of all woody vegetation and herbaceous vegetation which normally remains standing after the growing season (e.g., cattails and/or bulrushes)].	EFW,DFW,ESW, DSW	Line intercept, remote sensing
V_2	Percent of the year with surface water present (the proportion of the year in which wetland cover types have surface water present).	EFW,DFW,ESW, DSW,HW,R,L	Remote sensing, local data
V_3	Percent of wetland basin dominated by persistent emergent vegetation [e.g., the proportion of a wetland that supports emergent herbaceous vegetation which normally remains standing after the growing season (e.g., cattails and/or bulrushes)].	HW	Remote sensing
V_4	Percent tree and/or canopy closure within 100 m (328 ft) of the water's or wetland's edge [the percent of the ground surface within 100 m (328 ft) of the water's edge, or edge of a wetland, that is shaded by a vertical projection of the canopies of all woody vegetation].	EFW,DFW,ESW, DSW,HW,R,L	Remote sensing, line intercept

Figure 4. Definitions of variables and suggested measurement techniques.

Variable (definition)	Cover types	Suggested technique
V_5 Shoreline development factor (a ratio relating the relative edge of a water body to its area. To obtain a value for shoreline development, measure the length of the shoreline and the area of the water body. The ratio of shoreline to area is compared to that for a circle having the same area as the water body, using the following formula: $DI = \frac{l}{2\sqrt{A\pi}}$ where: DI = diversity index; l = length of shoreline; A = area of water body. A circle would have a value equal to 1.0. The greater the deviation from a circular shape, the greater the DI value will be).	L	Remote sensing, topographic map. Dot grid, planimeter.

Figure 4. (concluded).

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No other habitat models for the mink were located in the literature.

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Western Energy and Land Use Team
U.S. Fish and Wildlife Service
2627 Redwing Road
Fort Collins, CO 80526-2899

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16. Abstract (Limit: 200 words)

Habitat preferences of the mink (Mustela vison) are described in this publication, which is one in a series of Habitat Suitability Index (HSI) models. A review and synthesis of the literature is followed by development of a model of the habitat requirements of the mink within inland wetland areas throughout its range. HSI's are designed for use with Habitat Evaluation Procedures previously developed by the U.S. Fish and Wildlife Service.

This revision supersedes the October 1983 report.

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COMMON SNIPE
Grassland/Agricultural Type

General

Suitable year-round habitat for the common snipe (Capella gallinago) in Ecoregion 2410 is provided by riparian and grassland-agricultural plant communities having low vegetation, high soil moisture, and high organic matter content (Larrison and Sonnenberg 1968). Snipe are commonly found in upland and lowland wet pastures, wet sedge (Carex spp.) and grass (Poaceae) meadows and marshes, bogs, willow (Salix spp.) and alder (Alnus spp.) swamps, plowed fields, and in areas of decomposed wet plant litter along ponds, meandering rivers, and streams (Tuck 1972; Fogarty et al. 1977).

Food Requirements

Snipe use their long bills to probe the soil for animal matter, their major food item (White and Harris 1966; Johnson 1975). The preferred feeding areas have soft, organic soils as opposed to compacted, or inorganic, soils. Johnson (1975) measured soil compaction in relation to snipe feeding areas in Colorado using a Soiltest penetrometer. Soil compaction was influenced by soil texture and moisture, and vegetation density. Areas with pressure readings from 0.1 to 0.75 kg/cm^2 (instrument range, 0-4.5 kg/cm^2) had the highest snipe densities; 1.5 kg/cm^2 was suitable in areas of dense vegetation. Compaction readings above 2.5 kg/cm^2 represented slightly moist or dry ground which was unsuitable for foraging snipe.

Exposed, sparsely vegetated marshes, mud flats, and plowed or disked agricultural fields are suitable year-round feeding areas due to their open, disturbed quality (White and Harris 1966; Johnson 1975). In late summer, swampy areas that are too wet earlier in the season for nesting, and newly exposed mucky areas near ponds, lakes, and meandering rivers provide the snipe with feeding sites (Tuck 1972). Wet cattle pastures are important snipe winter foraging areas. Cow manure attracts snipe food animals (Tuck 1972; Johnson 1975). In winter, areas of exposed, organic, alkaline soil are the preferred feeding sites. In northern California, the preferred winter feeding areas had friable, humus-rich soils, a close cropped cover, and an abundance of small food animals (White and Harris 1966). Neely (1959) stated that snipe would not use areas with rank cover.

Approximately 80 percent of the snipe's diet is animal matter (Fogarty et al. 1977). This includes insects and their larvae, as well as earthworms, crustaceans, spiders, and mollusks (White and Harris 1966; Tuck 1972; and Fogarty et al. 1977). In a northern California study, plant material comprised roughly 20% of the diet (White and Harris 1966).

Water Requirements

No specific drinking water requirements were found in the literature.

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Cover Requirements

In spring, summer, and early fall, snipe cover requirements relate to breeding and are discussed in the section on Reproductive Requirements.

Escape and loafing cover and exposed organic soil are the critical components of snipe winter habitat (White and Harris 1966; Tuck 1972). Suitable winter habitat in northern California provided good visibility, walking and probing ease, and adjacent escape cover (White and Harris 1966). Sedges, thick willows, and alders provide suitable cover for snipe (Tuck 1972). This species returns to the same wintering areas year after year. In Colorado, wintering occurred along stream channels with sparsely vegetated, gently sloping shorelines of soft, water-saturated soils (Johnson 1975). Exposed mud flats with organic soils, and similar low, sparse vegetation also provided suitable habitat. Topography, vegetation height and density, and water levels relative to the shoreline were significant factors influencing selection of wintering areas.

In North America, marshes provide for snipe winter needs (Tuck 1972). Wet cattle pastures, periodically inundated, fallowed or harrowed agricultural fields, shallow farm ponds, and the edges of lakes, ditches, streams, and rivers are also important snipe wintering habitats (Johnson 1966; White and Harris 1966; Tuck 1972; and Fogarty et al. 1977).

Reproductive Requirements

In North America, the optimal breeding range of snipe is restricted to organic soils (Fogarty et al. 1977). In Colorado, the most suitable breeding habitats were areas of shallow, stable, discontinuous water levels (Johnson 1975; Johnson and Ryder 1977). Areas with continuous water coverage provided few unflooded sites for nesting. Nest sites were characteristically on moist sites adjacent to water, in grasses or sedges between 8 and 16 inches (20-40 cm) in height. Preferred ground conditions include moist to saturated organic soils characterized by hummocks. Vegetation of the breeding areas was between 4 and 12 inches (10-30 cm) in height (late May), often grazed or mowed and sparse. Vegetation less than 2 inches (5 cm) tall provided poor nesting cover. Johnson (1975) stated that water depths on snipe breeding grounds should not exceed 2-2.4 inches (5-6 cm). Partially flooded meadows, boglike areas with dense growths of sedge, open willow swamps, and other marshy areas along watercourses provide suitable nesting habitat (Boeker 1953; Tuck 1972). Various mosses, sedges, grasses, and low shrubs provide the desired low cover characteristics of summer breeding and feeding habitat (Fogarty et al. 1977). High, thick cover is a limiting factor which will prevent snipe use of an otherwise attractive breeding or wintering area. During the breeding season, male snipe require a display arena free of trees, tall shrubs or other obstacles to flight (Tuck 1972).

Special Habitat Requirements

No special habitat requirements were found in the literature.

Interspersion Requirements

Male snipe require escape cover adjacent to the nest site, usually within 26 to 230 feet (8-70 m), with a mean distance of 75.6 feet (20 m) (Tuck 1972). A shift in cover area use occurs with flooding or

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drying, or when vegetation becomes rank. Suitable feeding areas are near the nest and the male's shelter site.

Special Considerations

Common snipe may be found throughout the year in the Ecoregion although they are more common during the fall and spring migrations.

The destruction of wetlands through draining, filling, or other practices is detrimental to snipe populations (Tuck 1972; Fogarty et al. 1977). Projects which cause continuous flooding result in abandonment of the area by snipe (Johnson 1975).

Cattle use can be benefical to snipe because grazing can maintain areas of low, sparse vegetation (White and Harris 1966; Tuck 1972; and Johnson 1975). Johnson (1975) recommended applying animal waste to suitable snipe habitats and thereby increase the number and availability of larval insects. Extensive overgrazing lowers snipe densities if cattle crop the vegetation below optimal heights. The burning of marshes exposes the organic soil and benefits snipe by providing feeding areas (Tuck 1972). Agricultural activities such as plowing, planting, disking, and cultivation attract snipe by exposing food items and providing easier probing. The uneven, broken earth protects snipe against wind and predators (White and Harris 1966; Tuck 1972).

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HABITAT SUITABILITY INDEX

Common Snipe in Grassland/Agricultural Type

Ecoregion 2410

Food Value $(X_1) = (I_1 \times I_2 \times I_3)^{1/3}$

Where: I_1 = Suitability Index (SI) of soil moisture content.

I_2 = SI of height of herbaceous vegetation.

I_3 = SI of soil compaction.

Reproductive Value $(X_2) = (I_1 \times I_2)^{1/2}$

Where: I_1 = SI of soil moisture content.

I_2 = SI of height of herbaceous vegetation.

Cover needs are satisfied if reproductive needs are met.

The Habitat Suitability Index is the lowest X_n value.

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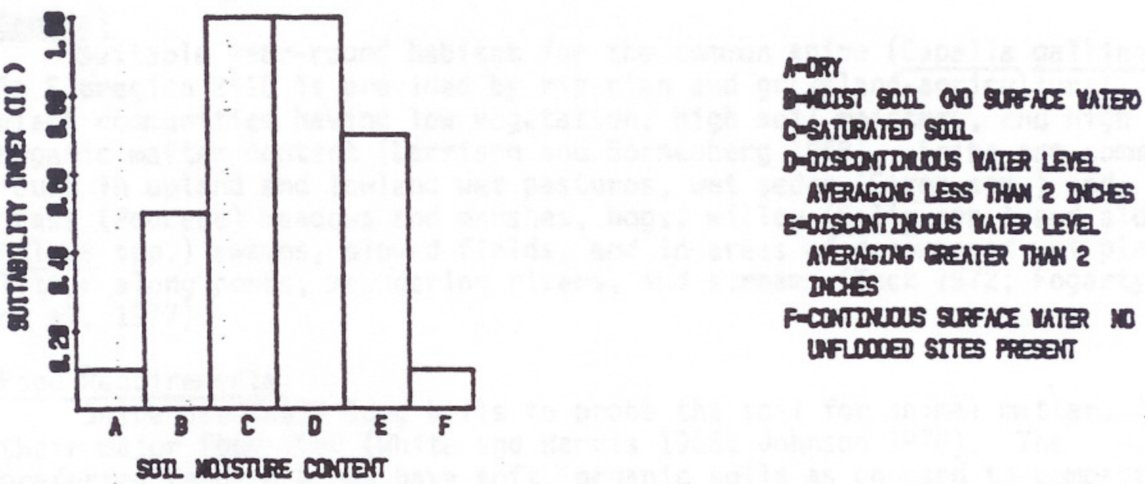
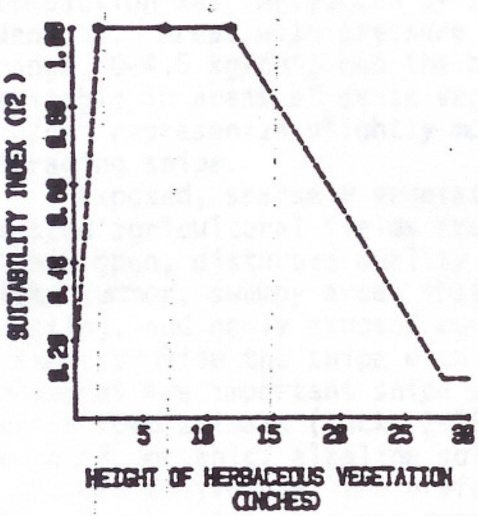
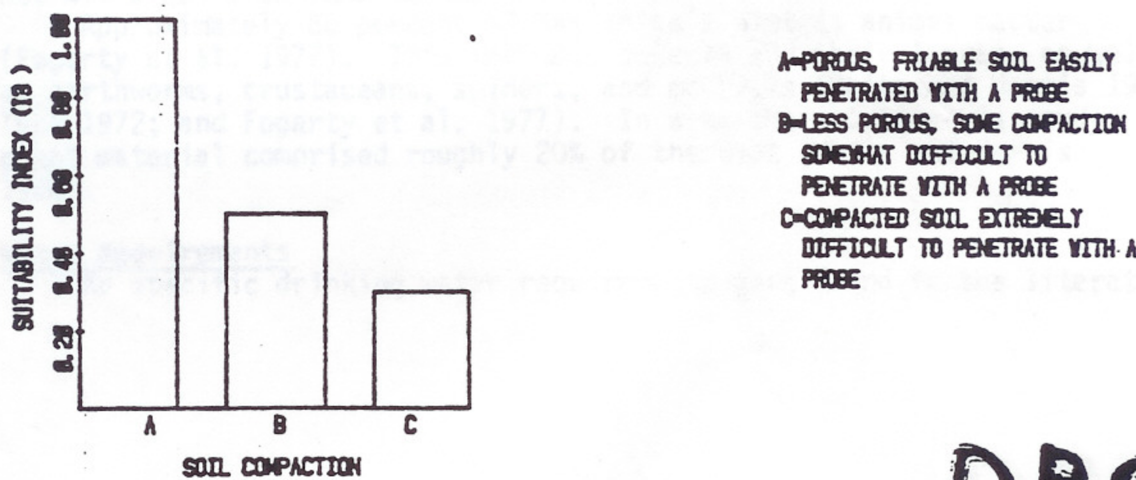
COMMON SNIPE

GRASSLAND/AGRICULTURAL







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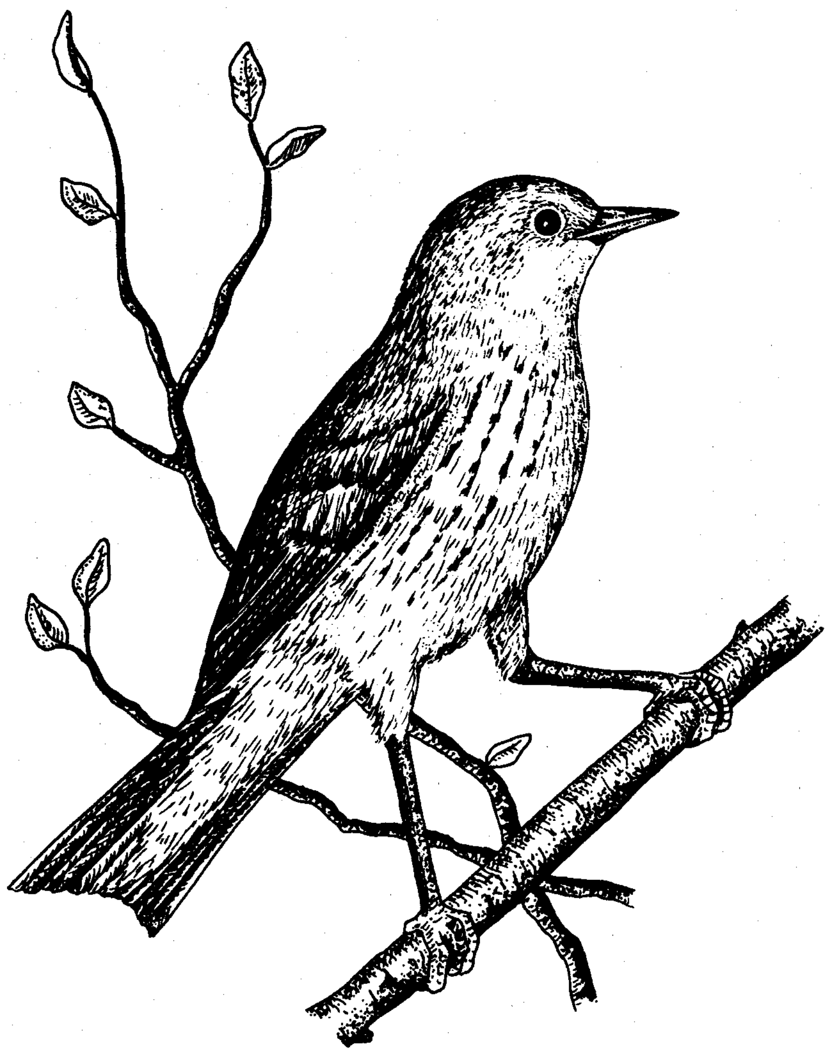
Biological Services Program
and
Division of Ecological Services

FWS/OBS-82/10.27
JULY 1982

HABITAT SUITABILITY INDEX MODELS: YELLOW WARBLER



Fish and Wildlife Service

U.S. Department of the Interior

The Biological Services Program was established within the U.S. Fish and Wildlife Service to supply scientific information and methodologies on key environmental issues that impact fish and wildlife resources and their supporting ecosystems. The mission of the program is as follows:

- To strengthen the Fish and Wildlife Service in its role as a primary source of information on national fish and wildlife resources, particularly in respect to environmental impact assessment.

- To gather, analyze, and present information that will aid decisionmakers in the identification and resolution of problems associated with major changes in land and water use.

- To provide better ecological information and evaluation for Department of the Interior development programs, such as those relating to energy development.

Information developed by the Biological Services Program is intended for use in the planning and decisionmaking process to prevent or minimize the impact of development on fish and wildlife. Research activities and technical assistance services are based on an analysis of the issues, a determination of the decisionmakers involved and their information needs, and an evaluation of the state of the art to identify information gaps and to determine priorities. This is a strategy that will ensure that the products produced and disseminated are timely and useful.

Projects have been initiated in the following areas: coal extraction and conversion; power plants; geothermal, mineral and oil shale development; water resource analysis, including stream alterations and western water allocation; coastal ecosystems and Outer Continental Shelf development; and systems inventory, including National Wetland Inventory, habitat classification and analysis, and information transfer.

The Biological Services Program consists of the Office of Biological Services in Washington, D.C., which is responsible for overall planning and management; National Teams, which provide the Program's central scientific and technical expertise and arrange for contracting biological services studies with states, universities, consulting firms, and others; Regional Staffs, who provide a link to problems at the operating level; and staffs at certain Fish and Wildlife Service research facilities, who conduct in-house research studies.

This model is designed to be used by the Division of Ecological Services in conjunction with the Habitat Evaluation Procedures.

FWS/OBS-82/10.27
July 1982

HABITAT SUITABILITY INDEX MODELS: YELLOW WARBLER

by

Richard L. Schroeder
Habitat Evaluation Procedures Group
Western Energy and Land Use Team
U.S. Fish and Wildlife Service
Drake Creekside Building One
2625 Redwing Road
Fort Collins, CO 80526

Western Energy and Land Use Team
Office of Biological Services
Fish and Wildlife Service
U.S. Department of the Interior
Washington, DC 20240

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PREFACE

This document is part of the Habitat Suitability Index (HSI) Model Series (FWS/OBS-82/10), which provides habitat information useful for impact assessment and habitat management. Several types of habitat information are provided. The Habitat Use Information Section is largely constrained to those data that can be used to derive quantitative relationships between key environmental variables and habitat suitability. The habitat use information provides the foundation for HSI models that follow. In addition, this same information may be useful in the development of other models more appropriate to specific assessment or evaluation needs.

The HSI Model Section documents a habitat model and information pertinent to its application. The model synthesizes the habitat use information into a framework appropriate for field application and is scaled to produce an index value between 0.0 (unsuitable habitat) and 1.0 (optimum habitat). The application information includes descriptions of the geographic ranges and seasonal application of the model, its current verification status, and a listing of model variables with recommended measurement techniques for each variable.

In essence, the model presented herein is a hypothesis of species-habitat relationships and not a statement of proven cause and effect relationships. Results of model performance tests, when available, are referenced. However, models that have demonstrated reliability in specific situations may prove unreliable in others. For this reason, feedback is encouraged from users of this model concerning improvements and other suggestions that may increase the utility and effectiveness of this habitat-based approach to fish and wildlife planning. Please send suggestions to:

Habitat Evaluation Procedures Group
Western Energy and Land Use Team
U.S. Fish and Wildlife Service
2625 Redwing Road
Ft. Collins, CO 80526

CONTENTS

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YELLOW WARBLER (*Dendroica petechia*)

HABITAT USE INFORMATION

General

The yellow warbler (*Dendroica petechia*) is a breeding bird throughout the entire United States, with the exception of parts of the Southeast (Robbins et al. 1966). Preferred habitats are wet areas with abundant shrubs or small trees (Bent 1953). Yellow warblers inhabit hedgerows, thickets, marshes, swamp edges (Starling 1978), aspen (*Populus* spp.) groves, and willow (*Salix* spp.) swamps (Salt 1957), as well as residential areas (Morse 1966).

Food

More than 90% of the food of yellow warblers is insects (Bent 1953), taken in proportion to their availability (Busby and Sealy 1979). Foraging in Maine occurred primarily on small limbs in deciduous foliage (Morse 1973).

Water

Dietary water requirements were not mentioned in the literature. Yellow warblers prefer wet habitats (Bent 1953; Morse 1966; Stauffer and Best 1980).

Cover

Cover needs of the yellow warbler are assumed to be the same as reproduction habitat needs and are discussed in the following section.

Reproduction

Preferred foraging and nesting habitats in the Northeast are wet areas, partially covered by willows and alders (*Alnus* spp.), ranging in height from 1.5 to 4 m (5 to 13.3 ft) (Morse 1966). It is unusual to find yellow warblers in extensive forests (Hebard 1961) with closed canopies (Morse 1966). Yellow warblers in small islands of mixed coniferous-deciduous growth in Maine utilized deciduous foliage far more frequently than would be expected by chance alone (Morse 1973). Coniferous areas were mostly avoided and areas of low deciduous growth preferred.

Nests are generally placed 0.9 to 2.4 m (3 to 8 ft) above the ground, and nest heights rarely exceed 9.1 to 12.2 m (30 to 40 ft) (Bent 1953). Plants used for nesting include willows, alders, and other hydrophytic shrubs and trees (Bent 1953), including box-elders (Acer negundo) and cottonwoods (Populus spp.) (Schrantz 1943). In Iowa, dense thickets were frequently occupied by yellow warblers while open thickets with widely spaced shrubs rarely contained nests (Kendeigh 1941).

Males frequently sing from exposed song perches (Kendeigh 1941; Ficken and Ficken 1965), although yellow warblers will nest in areas without elevated perches (Morse 1966).

A number of Breeding Bird Census reports (Van Velzen 1981) were summarized to determine nesting habitat needs of the yellow warbler, and a clear pattern of habitat preferences emerged. Yellow warblers nested in less than 5% of census areas comprised of extensive upland forested cover types (deciduous or coniferous) across the entire country. Approximately two-thirds of all census areas with deciduous shrub-dominated cover types were utilized, while shrub wetland types received 100% use. Wetlands dominated by shrubs had the highest average breeding densities of all cover types [2.04 males per ha (2.5 acre)]. Approximately two-thirds of the census areas comprised of forested draws and riparian forests of the western United States were used, but average densities were low [0.5 males per ha (2.5 acre)].

Interspersion

Yellow warblers in Iowa have been reported to prefer edge habitats (Kendeigh 1941; Stauffer and Best 1980). Territory size has been reported as 0.16 ha (0.4 acre) (Kendeigh 1941) and 0.15 ha (0.37 acre) (Kammeraad 1964).

Special Considerations

The yellow warbler has been on the Audubon Society's Blue List of declining birds for 9 of the last 10 years (Tate 1981).

HABITAT SUITABILITY INDEX (HSI) MODEL

Model Applicability

Geographic area. This model has been developed for application within the breeding range of the yellow warbler.

Season. This model was developed to evaluate the breeding season habitat needs of the yellow warbler.

Cover types. This model was developed to evaluate habitat in the dominant cover types used by the yellow warbler: Deciduous Shrubland (DS) and Deciduous Scrub/Shrub Wetland (DSW) (terminology follows that of U.S. Fish and Wildlife Service 1981). Yellow warblers only occasionally utilize forested habitats and reported population densities in forests are low. The habitat requirements in forested habitats are not well documented in the literature. For these reasons, this model does not consider forested cover types.

Minimum habitat area. Minimum habitat area is defined as the minimum amount of contiguous habitat that is required before an area will be occupied by a species. Information on the minimum habitat area for the yellow warbler was not located in the literature. Based on reported territory sizes, it is assumed that at least 0.15 ha (0.37 acre) of suitable habitat must be available for the yellow warbler to occupy an area. If less than this amount is present, the HSI is assumed to be 0.0.

Verification level. Previous drafts of the yellow warbler habitat model were reviewed by Douglass H. Morse and specific comments were incorporated into the current model (Morse, pers. comm.).

Model Description

Overview. This model considers the quality of the reproduction (nesting) habitat needs of the yellow warbler to determine overall habitat suitability. Food, cover, and water requirements are assumed to be met by nesting needs.

The relationship between habitat variables, life requisites, cover types, and the HSI for the yellow warbler is illustrated in Figure 1.

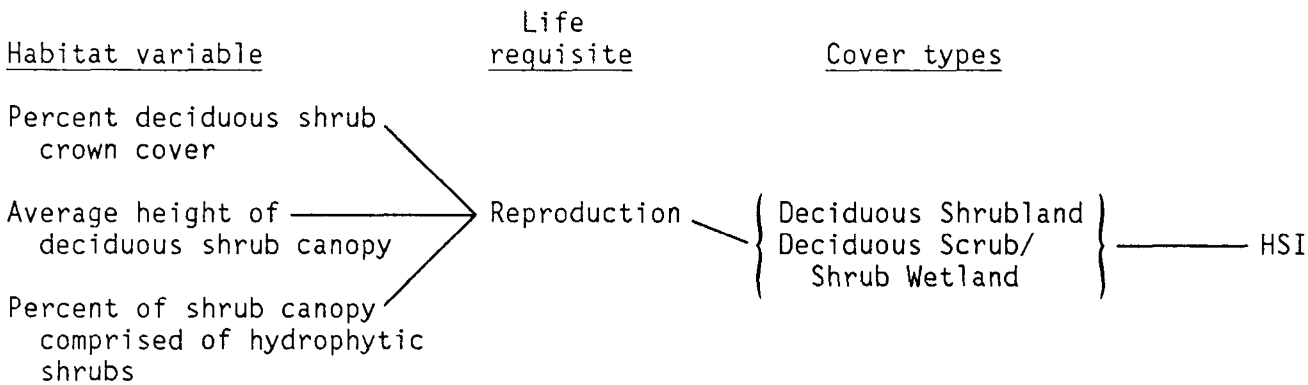


Figure 1. Relationship between habitat variables, life requisites, cover types, and the HSI for the yellow warbler.

The following sections provide a written documentation of the logic and assumptions used to interpret the habitat information for the yellow warbler and to explain and justify the variables and equations that are used in the HSI model. Specifically, these sections cover the following: (1) identification of variables that will be used in the model; (2) definition and justification of the suitability levels of each variable; and (3) description of the assumed relationship between variables.

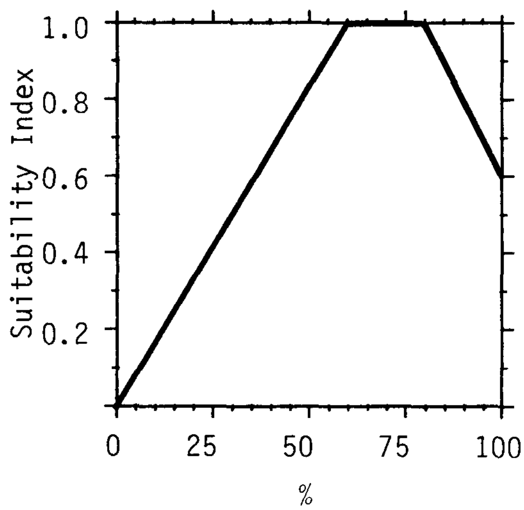
Reproduction component. Optimal nesting habitat for the yellow warbler is provided in wet areas with dense, moderately tall stands of hydrophytic deciduous shrubs. Upland shrub habitats on dry sites will provide only marginal suitability.

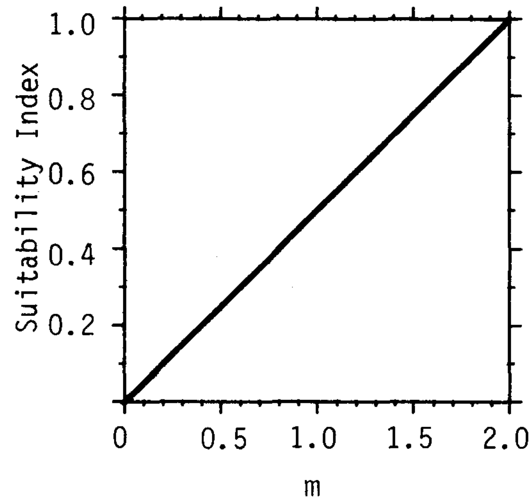
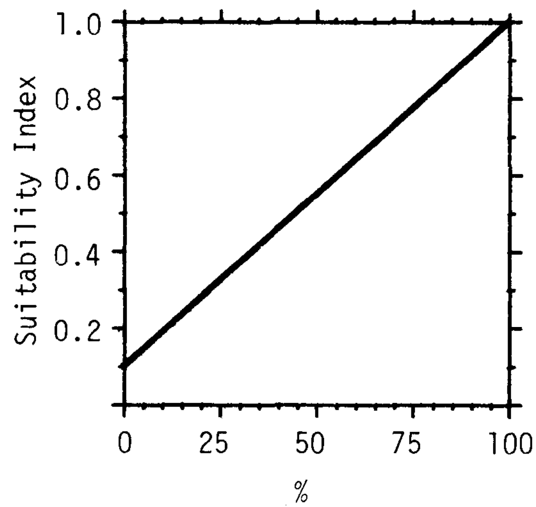
It is assumed that optimal habitats contain 100% hydrophytic deciduous shrubs and that habitats with no hydrophytic shrubs will provide marginal suitability. Shrub densities between 60 and 80% crown cover are assumed to be optimal. As shrub densities approach zero cover, suitability also approaches zero. Totally closed shrub canopies are assumed to be of only moderate suitability, due to the probable restrictions on movement of the warblers in those conditions. Shrub heights of 2 m (6.6 ft) or greater are assumed to be optimal, and suitability will decrease as heights decrease to zero.

Each of these habitat variables exert a major influence in determining overall habitat quality for the yellow warbler. A habitat must contain optimal levels of all variables to have maximum suitability. Low values of any one variable may be partially offset by higher values of the remaining variables. Habitats with low values for two or more variables will provide low overall suitability levels.

Model Relationships

Suitability Index (SI) graphs for habitat variables. This section contains suitability index graphs that illustrate the habitat relationships described in the previous section.

Cover type	Variable		
DS,DSW	V_1	Percent deciduous shrub crown cover.	

DS,DSW	V_2	Average height of deciduous shrub canopy.	
DS,DSW	V_3	Percent of deciduous shrub canopy comprised of hydrophytic shrubs.	

Equations. In order to obtain life requisite values for the yellow warbler, the SI values for appropriate variables must be combined with the use of equations. A discussion and explanation of the assumed relationship between variables was included under Model Description, and the specific equation in this model was chosen to mimic these perceived biological relationships as closely as possible. The suggested equation for obtaining a reproduction value is presented below.

Life requisite	Cover type	Equation
Reproduction	DS,DSW	$(V_1 \times V_2 \times V_3)^{1/2}$

HSI determination. The HSI value for the yellow warbler is equal to the reproduction value.

Application of the Model

Definitions of variables and suggested field measurement techniques (Hays et al. 1981) are provided in Figure 2.

Variable (definition)		Cover types	Suggested technique
V_1	Percent deciduous shrub crown cover (the percent of the ground that is shaded by a vertical projection of the canopies of woody deciduous vegetation which are less than 5 m (16.5 ft) in height).	DS,DSW	Line intercept
V_2	Average height of deciduous shrub canopy (the average height from the ground surface to the top of those shrubs which comprise the uppermost shrub canopy).	DW,DSW	Graduated rod
V_3	Percent of deciduous shrub canopy comprised of hydrophytic shrubs (the relative percent of the amount of hydrophytic shrubs compared to all shrubs, based on canopy cover).	DS,DSW	Line intercept

Figure 2. Definitions of variables and suggested measurement techniques.

SOURCES OF OTHER MODELS

No other habitat models for the yellow warbler were located.

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15. Supplementary Notes

16. Abstract (Limit: 200 words)

Habitat preferences of the yellow warbler (Dendroica petechia) are described in this publication. It is one of a series of Habitat Suitability Index (HSI) models and was developed through an analysis of available information on the species-habitat requirements of the species. Habitat use information is presented in a review of the literature, followed by the development of an HSI model, designed for use in impact assessment and habitat management activities.

17. Document Analysis a. Descriptors

Animal behavior
Birds
Wildlife
Habits
Mathematical models

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DEPARTMENT OF THE INTERIOR
U.S. FISH AND WILDLIFE SERVICE

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

HABITAT EVALUATION CRITERIA

Food - Evaluate food primarily using the criteria listed below. Mallards usually feed in open, shallow water; however, grain crops can suplement a natural diet substantially if they occur within close proximity to water, especially in winter. The amount of waste grain available will effect winter food value.

C1 = Summer Food Value is a function of:
The percent of available water that is slow moving, shallow, and open enough to allow a dabbling duck to feed.

a. 75-100% .... (0.8-1.0 SI)
b. 25-75% .... (0.4-0.7 SI)
c. 25% .... (0.1-0.3 SI)

Cover - Evaluate cover primarily using the criteria listed below. Broods are most susceptible to predation when escape cover is lacking. Sufficient amounts of aquatic vegetation supply necessary escape cover.

C3 = Summer Cover Value is a function of:
Percent of shoreline dominated by emergent or scrub-shrub vegetation.

a. 50-100% .... (0.7-1.0 SI)
b. 15-50% .... (0.4-0.6 SI)
c. 0-15% .... (0.1-0.3 SI)

Reproduction - Evaluate reproduction primarily using the criteria listed below. The abundance and patchiness of dense nesting cover (DNC) and the suitability of available water will largely influence reproductive value. Suitability of DNC increases with height.

C4 = Reproductive Value is a function of:
The distance between water bodies suitable for brood rearing and dense herbaceous cover at least 20 cm (8 inches) tall.

a. Immediately adjacent to each other .... (0.9-1.0 SI)
b. 10-90 m .... (0.6-0.8 SI)
c. > 90 m .... (0.1-0.5 SI)
